Mechanical World —— December 1959

Objective Maintenance

THE Egyptian pyramids have stood for thousands of years and they are still there for all to see, but they show the ravages of time and of depredation. Had they been continuously the subject of planned maintenance they would not have lost so much of their original form and decoration. The pyramids, like the early engine houses, were built to last a very long time, but the early engine houses were not given the same chance. Their engines soon became obsolete and the houses were demolished. The engines of the mature reciprocating period were like their houses, built to last, and there are some that would still go, apparently immune from wear and tear as long as they were kept clean and properly lubricated.

The present age demands much more from its machinery—and for that matter from all else it uses—and is willing to sacrifice some working life to an optimum economic gain. It pays better to wear out a machine in a certain time with a known expenditure on pre-planned repair and renewal (preventive maintenance) than to keep performance within the bounds of the asymptote of longevity by a duty level so low as not to incur deterioration.

An important contributory factor in the "limited life" policy is the expectation that almost any installation will be overtaken by an improved design as soon as, and often before, its economic life has run out, but without that the question is still one of the optimum combination of the various elements which make up the total annual cost. If finality in design were to be reached then the life factor would be reduced to what had to be done about the renewable wearing parts, and if metallurgical research and perhaps lubrication and other chemical research were to endow them with permanence, then, like the old steam engine, we should be back to cleaning, though that might take some elaborate form and be mitigated by a controlled atmosphere.

This apparently ideal condition is very likely illusory, and possibly only belongs to the stagnation of completely crystallized circumstances. While there is change and development the ideal offers an objective, and a good one, though it can never be reached. The newest manufacturing processes aim at being automatic, but as yet they do not run entirely without supervision or attention, though it is not inconceivable that a sufficiently programmed computer could initiate and exercise control in every possible circumstance, even to making replacements when required. This would do well enough for some things, but the idea is a product of the present and before it can become reality there will be further development. This, in turn, will open up new possibilities: in fact the opportunities seem to be limited only by the energy with which they are sought. As long as there are sufficient people with enough energy to do the seeking, there will, as a consequence, be enough to occupy all the rest in keeping the automated sub-stratum in working order.

LOG SHEET

Esso at Milford Haven

Work on the 4½ million ton per annum (100,000 barrels per stream day) Esso Refinery at Milford Haven was approximately half complete last July. The refinery is designed to operate on Middle East crude oil and will make propane, butane, petrols, turbo-jet fuels, autodiesel, gas oil and fuel oils. The project is anticipated to cost about £18,000,000 and to go "on stream" in November, 1960.

Grading of the site is complete and approximately 7½ miles of roads, the total refinery network, are finished. Much of the preliminary work on a refinery lies underground and hidden from view. This includes sewers, drains, fire mains and the like, which consist of pipes varying up to 54 in. dia, and these are finished.

There will be 68 storage tanks and, in addition, butane and propane spheres and storage drums. Of the 68 tanks, 40 tanks will be of the "floating roof" type which not only minimizes evaporation but also air pollution from volatile products. Some of the tanks have already been hydrostatically tested and are ready for service. In the shape of a letter T, the marine terminal extends approximately 3,500 ft into the deep waters of the Haven and is headed by two outside berths to take up to 100,000 d.w.t. tankers and an inside berth up to 5,000 d.w.t. ships. A feature of the design is the accessibility for small vessels to pass under the approach jetty to minimize inconvenience.

In the plant there will be a single stage atmospheric 100,000 B/D pipestill together with gas compression, stabilization and naphtha splitting facilities. The purpose of the pipestill is to obtain as exact a separation as possible of the large number of liquid hydrocarbons which make up crude oil into raw materials for the manufacture of petrol, jet fuels, heating oils and fuel oils. The crude oil is heated to a temperature around 750°F and is fed into the fractionating tower as a mixture of vapour and liquid. The liquid drops to the bottom, and the vapours condense on trays at different levels up the tower. The furnace of this pipestill is the largest of its kind in the world, with a heat output of about 500 million B.th.u/hr.

The Hydrofiner is an Esso Research and Engineering Company design and comprises a fixed bed catalytic hydrogen treating process, employing hydrogen from the Powerformer. It is used for the reduction of the sulphur content of naphthas and diesel oils. The vaporized product is contacted with hydrogen in the presence of a catalyst, and the sulphur is removed in the form of hydrogen sulphide.

The Powerformer is also an Esso Research and Engineering Company design. The Powerforming process provides a means for converting a low octane naphtha (a crude form of petrol) to a high octane component of premium motor spirit. The naphtha is first Hydrofined for the removal of sulphur, and then reformed over a platinum catalyst in an atmosphere of hydrogen at a high pressure.

The light naphtha and turbo-jet fuels from the distillation unit will be treated in a copper chloride sweetening plant for the conversion of corrosive and unpleasant smelling compounds, in order to give a non-corrosive product with a pleasant odour.

Two Foster Wheeler boilers each of 130,000 lb/hr at 150 psig and 450°F will be installed to provide steam for process and power requirements. The boilers will be combination gas and oil fired, either separately or proportionally.

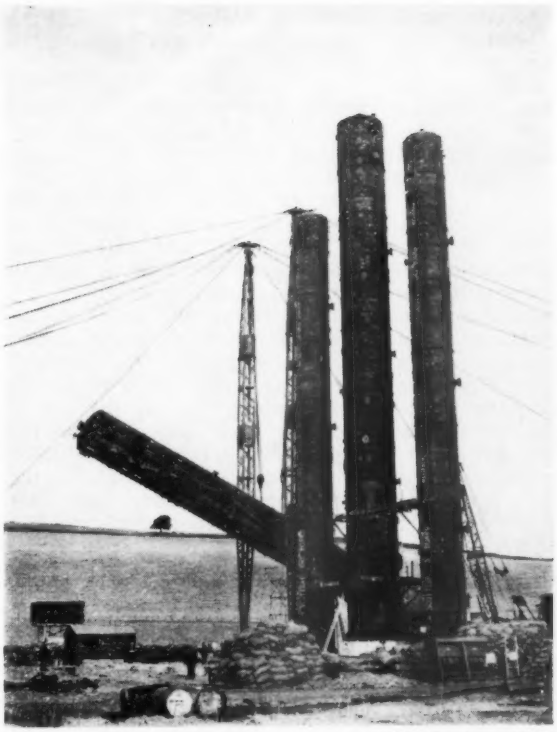
Apart from the boiler house there is only one process control room for the whole refinery. All process operations will be controlled from this point by means of remote controls on a graphic panel.

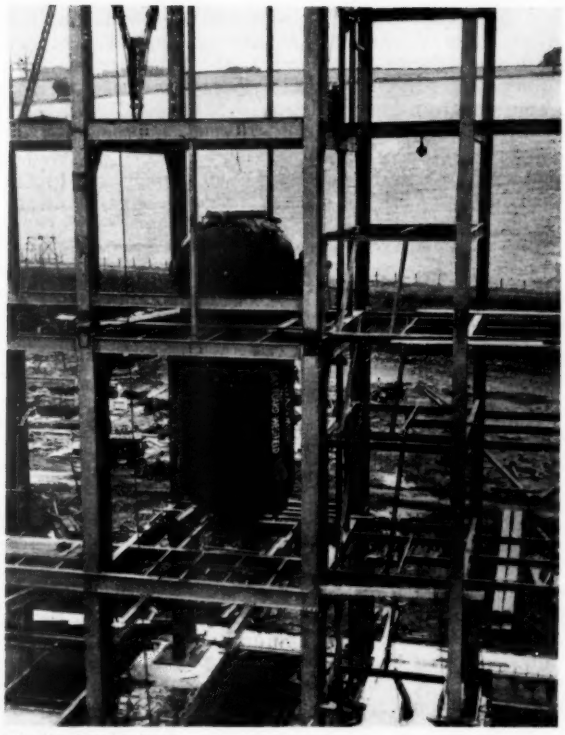
Industrial landscaping and design has ensured that the Refinery is not only a clean, compact place but it is also integrated with its surroundings. The services have been retained of Mr. S. Colwyn Foulkes, O.B.E., F.R.I.B.A., Fellow of the Institute of Landscape Architects, to see that this refinery is a model for future industrial developments. By careful siting, the majority of plant and tankage is hidden within a natural ravine; that which is exposed will be painted to blend with the surroundings, and where possible, tree belts will be planted to afford a screen from the land side and the sea.

Wear Resistance

After considerable development, the Amar Tool and Gauge Company Limited, of Chadwell Heath, Essex, have perfected the production of nitrided gap gauges to such a degree that each gauge in their entire range

MEREMERE POWER STATION.—Manufactured by the A.E.I. Turbine-Generator Division, Trafford Park Works, three 30-MW Metropolitan-Vickers turbine-generator sets supply half the output of the Meremere Power Station, which is the first coal burning power station in New Zealand. Included with the generating equipment were three twin-shell condensing plants, with ejectors and extraction pumps, and three four-stage feed water heating equipments. Other A.E.I. equipment at Meremere includes a turbine gaugeboard, a field suppression cubicle, automatic voltage regulating equipment, a neutral earthing cubicle, all the electric motors for coal handling and oil feed machines and most of the motors for other drives throughout the station





These four towers, which form a landmark on the site of Britain's first high pressure gasification plant at Westfield, Fife, will be used in the Benfield process to wash out unwanted carbon dioxide and hydrogen sulphide from the gas before it is distributed into the new high pressure grid serving the industrial areas of Scotland. Two towers are 95 ft high; the others, 110 ft: each has a diameter of about 10 ft. G. A. Harvey Limited, of Greenwich, London, who have had a great deal of experience in the fabrication of high pressure vessels, are supplying the main Benfield Absorber vessels, each weighing some 90 tons unladen. Their normal working pressure will be 345 psig. At right is illustrated the first of the three Lurgi gasifiers—the core of the high pressure gasification plant which is being built by Humphreys and Glasgow Limited for the Scottish Gas Board—is shown in position in the steel building which has been erected to house them. Each gasifier weighs 50 tons. Exceptionally strong, 36 in. by 16½ in. steel universal beams were used for the structure of the building

is being produced as a nitrided product. Appreciable economic advantages will be offered by the long life of these gauges, coupled with the fact that little or no price increase is envisaged.

Another interesting development, also successful in prolonging tool life, concerns taps for use on abrasive materials. The company recently supplied a quantity of taps to be used on unfired ceramics. Whereas a normal tap would last for perhaps 60 operations, the Amar taps—produced from solid carbide—already with a life of 1800 operations, are reported to be still in use and there is every indication of continued long life.

Lurgi Gas Plant

No plant exactly like the £6,600,000 Lurgi gas plant under construction at Westfield, Fife, has been built anywhere in the world before. Humphreys and Glasgow Limited, who designed the plant and are erecting it for the Scottish Gas Board, are working in conjunction with the board's engineers to solve a variety of new problems. Their work will help to decide the shape of Britain's gas plants of the future. The first stage of the project is expected to be operating by autumn, 1960, and gasmaking—with an output of 15 million cu ft of gas a day, made from low-grade coal—by the beginning of 1961.

The decision to build the plant was reported in our February "log" pages.

The Lurgi process for the complete gasification of coal under high pressure originated in Germany a few years before the outbreak of the Second World War. The new plant will produce gas by chemical processes and practice from a type of coal completely unsuitable for carbonization by conventional means.

At Westfield unwashed opencast coal will be fed directly by conveyor belt into the works: ash from the gas plant will be returned by conveyor belt to the opencast site to aid in land filling.

Coal will be crushed and screened to give a graded fuel for gasification and the larger coal will be be fed to the Lurgi generators for gasmaking; the remaining smaller coal will be used for steam raising. Large quantities of steam are required because the gas is made by the reaction with coal of steam and oxygen under high pressure. The generators are being provided under an agreement made between Humphreys and Glasgow Limited (the main contractors for the works) in association with the Power-Gas Corporation Limited and the German firm which originated the process.

After purification the gas produced by the Lurgi generators will have a heating value of just over 400 British thermal units per cu ft. In the first stage this gas will be enriched to 450 B.t.u. per cu ft by the addition of butane purchased from Grangemouth oil refinery.

After leaving the Lurgi generators the gas will be cooled. Crude benzole will be recovered from it for sale, and the gas will then pass to the Benfield plant for the removal of two unwanted constituents—carbon dioxide and hydrogen sulphide—which will be washed out. The Benfield plant will be visually one of the most striking parts of the plant, consisting of tall steel cylinders like the cracking towers of an oil refinery. In this process the carbon dioxide and hydrogen sulphide are absorbed by a

hot potassium carbonate solution. After these substances are driven from the solution by steaming, the solution is ready to absorb more impurities from the gas.

Any remaining traces of hydrogen sulphide will be removed in high-pressure tower purifiers. The gas will then be ready for distribution, and the pressure remaining in it at the end of the production stream will be sufficiently high to enable it to be distributed throughout the grid area without further expenditure of power.

One great advantage of the Lurgi process is that gas is produced at such high pressure that it can be readily distributed through pipelines over considerable distances without using compressors along the route. A new pipeline which will carry the gas from Westfield to local grid systems round Glasgow in the west and Perth and Dundee in the north, will be designed for a maximum working pressure of 300 psi. The total length of 12-in. steel pipeline to be laid from Westfield to Coatbridge in the west and Dundee in the north is 75 miles. A further 58 miles of steel branch lines ranging from 8 in. to 3 in. dia will supply individual undertakings and local grid systems.

The pipes are made in lengths of 25 to 45 ft of seamless solid drawn steel, protected on the outside with woven glass reinforced bitumen asbestos sheathing, and coated on the inside with red lead paint. They are manufactured in Scotland and delivered by road to storage dumps along the route planned for the pipeline.

The pipes are taken from the storage dumps and strung along the prepared route. They are then welded together above ground to form a continuous line. All joints are tested with ultrasonic and radiographic equipment. The external protective sheathing is also tested for damage and flaws by submitting it to a high electric potential difference. Any breaks in the sheathing are indicated by a high-tension spark which jumps from the detector to the exposed metal of the pipeline at the point where the electrical insulation is incomplete. These points are carefully repaired by applying molten bitumen before the pipes are buried.

The trench to accommodate the completed pipeline is excavated by a rotary ditcher capable of removing soil to a depth of 4 ft or more while moving forward at a rate of over 10 ft per min given reasonable ground conditions. The continuous line of steel pipe is "snaked" into the trench by means of mobile cranes. The pipeline is then packed round with soil before bulldozers fill in the remaining ground that has been removed in trenching; and finally the top soil is restored to its original position.

Instrument Research

The Cambridge Instrument Company Limited's new research laboratories at Cambridge are the outcome of an enlightened research and development policy that began nearly 80 years ago with Horace Darwin's original conception of providing precision instruments for research workers in universities.

Starting with a small workshop and a staff of seven in 1881, the company has steadily grown in size and stature until today it has become one of Britain's foremost instrument manufacturers, with three factories in the U.K., associated companies in the U.S. and Australia, and accredited agents and dealers in over 30 different countries. Its range of manufacture is unsurpassed in diversity and the name Cambridge stands for quality the world over.

The company's success and present high standing in all branches of instrumentation have been due primarily to the quality and loyalty over a long period of the individuals of which it is composed. An important contributory factor has been the very close relations it has fostered with universities and research establishments. Many distinguished scientists and engineers, such as H. L. Callendar, E. H. Griffiths, G. A. Shakespear, C. R. T. Wilson, W. D. Duddell, H. A. Daynes, etc., have brought their problems to Cambridge, and their names are now inseparably associated with instruments that were designed, made, and first marketed by the company. This admirable tradition is still followed and evidence of this today is to be found in instruments such as the Huxley microtome, the dye-dilution curve recording apparatus, and the electron-probe scanning X-ray microanalyser.

The new laboratories, which consist primarily of a three-storied entrance block and four-storied laboratory block sited adjacent to the Cambridge factory, are an excellent example of co-operation between the scientist on the one hand and the architect and builder on the other. Construction commenced in September, 1958 and the building contract was completed in just under a year.

The company's research and development programme is based firstly upon the need for fundamental research into new and more elegant methods of measurement; secondly, upon the need to exploit fully the application of existing methods in science, industry, and medicine; and thirdly, upon the need to improve and develop existing designs.

By providing this new building, with its ideal working conditions and first-class equipment, the company has already done much to further these projects, but in the end it knows it must again look to the valuable human material upon which it has placed so much reliance in the past before it can count upon that "flash of inspiration which marks a new advance".

The company is thus very much alive to the "fallacy of dogmatic finality", as A. N. Whitehead called it. It refuses to accept finality in all things and the new building is an expression of its philosophy. Further evidence of this is to be found in an important extension, now nearing completion, at the Muswell Hill factory, and this is to be followed in a few months by a modern club house which will improve the amenities for employees at that centre. Another large modern building has been planned for the Cambridge factory and, during the past few months, the head offices in London have been doubled in size.

The erection of the new laboratories must, therefore, be seen in the wider context of the integrated expansion of research, production, and sales which are now being pushed ahead vigorously to provide a broader base for the company's activities in the future—activities that penetrate into almost all fields of human endeavour; industrial, scientific, educational, medical.

Ropemakers' Golden Jubilee

In 1909 Herbert Ingold saw great opportunities for expansion of the wire rope trade and, in conjunction with Herbert Calvert Wood, a chartered surveyor and Director of several companies, Granville Chambers, an eminent mining engineer, and John Truman Barker, he obtained an option on a plot of land at Darnall, and founded the Sheffield Wire Rope Company

Limited, which celebrates its Golden Jubilee this year.

The new concern expanded steadily and extensions to the works became necessary at almost regular intervals of three or four years until, with the last taking place in 1950, the factory covers almost ten times the area occupied at its foundation.

Like many other firms in the industry, during both world wars most of its output was absorbed by the Admiralty; and by the early 1920's the company had to some extent, specialized in the making of what were then very large ropes in one continuous length. Two examples may suffice: $\frac{13}{16}$ in. dia rope, $8\frac{1}{4}$ miles in length, and another $\frac{7}{8}$ in. dia rope, $11\frac{1}{4}$ miles in length, without splice: at that time there were very few firms who were equipped to carry out such work.

In 1940, when enemy air raids became intense, a 500 lb bomb fell within a few yards of the works but luckily the damage it caused was confined to the roof, and the machinery was unharmed so that within ten days normal working was resumed, and a month afterwards temporary repairs to the roof were completed.

To mark the occasion of the firm's fortieth anniversary, a pension scheme for both staff and workers was instituted. It is especially worthy of note that Mr. B. Allen (Sales Director) has been with the firm since its birth, and Mr. S. K. Wheatley (Secretary and Director), and Mr. H. V. W. Buckler (Works Director) have served the firm for more than 40 years. Seven other members of the staff and works have also reached the 40 year mark and over 50% of the male employees have a service of over 25 years.

Early in 1959 the company was acquired by the Firth Cleveland Group of which Mr. C. W. Hayward is chairman and managing director.

Sea Pipeline

The world's heaviest sea pipeline, total deadweight about 2,000 tons and over a mile long, was laid in October last in Ga Lagoon, Gulf of Guinea, Ghana, by Taylor Woodrow (Ghana) Limited, in association with Collins Submarine Pipelines Overseas Limited. The pipe forms a sewer outfall from Tema 6,000 ft in length.

Some 210 short lengths of pipe in all (from Stewart & Lloyds Limited) were welded together and coated with successive anti-corrosion layers of enamel, glass fibre and bitumen, surmounted by a six-inch layer of reinforced concrete. The inside was coated with a bitumen-sealed layer of cement mortar applied mechanically by Mowlem Centrilene Limited, using a machine travelling along the pipe interior. Each weld was X-rayed, films being developed on the spot (in a portable dark room) and the whole pipeline was cathodically protected against corrosion. When completed each yard length of pipeline weighed over one ton and measured $3\frac{1}{2}$ ft in dia.

The world's heaviest sea pipeline, total deadweight about 2000 tons and over a mile long, being laid off Ghana. Buoyancy pontoons are seen strapped on top of the pipe with launching units underneath. Control tower on right was in touch with barge out to sea and hold-back winch on landward end of line

For launching, the leading end of the pipe was encased in a 40-ton concrete pulling sledge, which also helped to anchor the pipe on the final position on the sea bed where it terminated in about 35 ft of water. The pipe was pulled out to sea by a winch stationed on a barge anchored outside the lagoon. Special launching units placed at intervals facilitated the pipe's progress over the ground and pontoons placed at calculated intervals gave buoyancy in its progress along the sea bed. These pontoons were later freed by a patented release mechanism operated by a team of skin divers.

The launching signal was given by Dr. Nkrumah, the Prime Minister of Ghana.

Furnace Instrumentation

The instruments which control the 100 ton oil-fired furnace at the Glamorgan works of the Briton Ferry Steel Company Limited, designed by Maerz Industrie-Ofenbau A.G. of Zürich and supplied, together with equipment by George Kent Limited, Luton, to the order of Priest Furnaces Limited, Middlesbrough—are housed as a single presentation unit in a combined cabin-type panel and plate-glass-fronted control cubicle.

Two noteworthy features are the provision of a direction-of-firing automatic reversal system initiated by a Multelec Mark 2 temperature-difference instrument (with over-riding reversal on time interval) Lorking in conjunction with two wand radiation pyrometers, and a Commander KE electronic liquid-steel temperature indicator with a range of 1250°–1750° C.

Accessories such as selector switches, manual reversal switches, push-buttons for door opening and pneumatic auto/manual/test/service stations are externally mounted on a forward control desk, enabling instrument readings to be observed and any required adjustments to be made without entering the cubicle.

Positioned on anti-vibration mountings of the Silent-Bloc pattern, the instrument-panel/control-cubicle assembly also embodies over-all panel lighting; individual instrument illumination; sealed, locking doors; and automatic pressurization for dust exclusion.

Belt Friction and Shaft Load

The total load on a pulley shaft due to belt tensions is analyzed for static, limiting and normal operating conditions. The variation of this load with angle of lap is illustrated

By O. R. FENDRICH, B.Sc.(Eng.), A.M.I.Mech.E.

Static conditions

If a belt is to be used to transmit power, it is necessary to provide a uniform static or "initial" tension before the drive is taken up. The resultant force on the shaft will then be

$$P_o = 2T_o \sin \tfrac{1}{2}\theta$$

Where T_o = initial tension.
θ = angle of lap.

The line of action P_o will pass through the point of intersection of the end tensions, and also through the pulley centre as shown in Fig. 1.

Limiting conditions

When the drive is taken up, the tension on one side of the belt will increase while that on the other side will decrease until the torque produced by the tension difference is sufficient to overcome the external resisting torque on the driven pulley. This tension difference reaches its greatest value when the belt begins to slip bodily over the pulley surface. If the tight side tension = T_1 and the slack side tension = T_2, then, for the limiting conditions described, and assuming a thin flat belt,

$$T_1/T_2 = e^{\mu\theta}$$

where μ = coefficient of friction between belt and pulley (assumed uniform).

The effect on the resultant pulley load P is shown in Fig. 2.

Now, $$P = \sqrt{T_1^2 + T_2^2 - 2T_1 T_2 \cos\theta}$$
$$= T_2\sqrt{e^{2\mu\theta} + 1 - 2e^{\mu\theta}\cos\theta}$$

and its line of action, though still passing through the intersection of the lines of action of T_1 and T_2, is now displaced from the pulley centre by a distance d. Since the torque on the pulley due to the belt tensions is $(T_1 - T_2)\,R$ it follows that

$$Pd = (T_1 - T_2)R$$

and hence $$d = (T_1 - T_2)R/P$$

where R = pulley radius.

$(T_1 - T_2)$ is the tangential friction force between belt and pulley so that the ratio $(T_1 - T_2)/P$ indicates the "efficiency" with which the total shaft load P is utilized as useful driving force.

Graphs of P and $(T_1 - T_2)/P$ against θ for various values of μ are shown in Figs 3 and 4, the graphs being plotted for $T_2 = 10$.

In Fig 3 it should be noted that for low values of μ the slope of the curve alternates between positive and negative, while for the higher values the slope is always positive. It can be shown that the limiting value of μ from

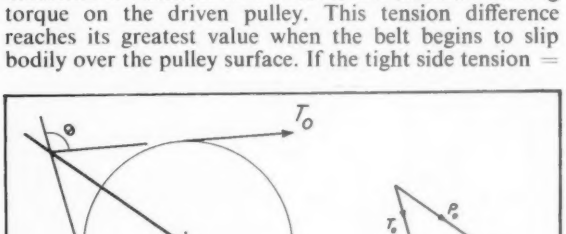


Fig. 1.—Static belt condition. The resultant passes through the pulley centre

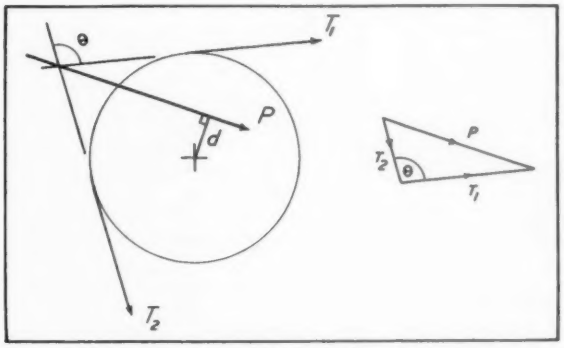


Fig. 2.—Driving condition. The resultant is at a distance d from the pulley centre

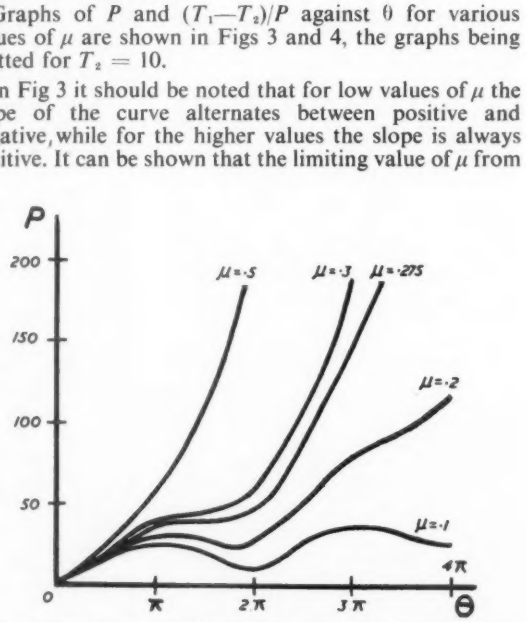


Fig. 3.—Variation of resultant with angle of lap for various values of coefficient of friction

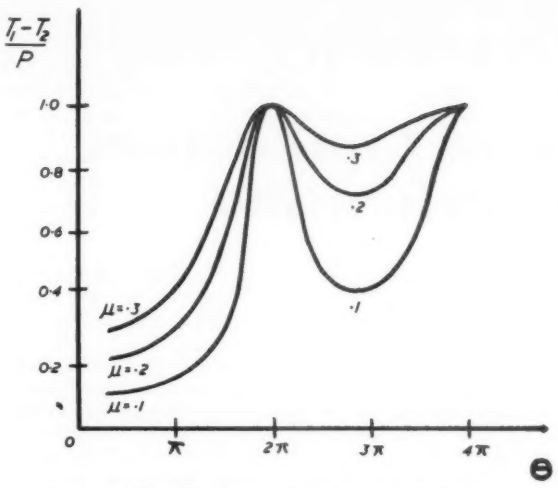


Fig. 4.—Variation of "efficiency" of load utilization with angle of lap

this point of view (i.e., the least value of μ for which the slope of the P curve is never negative) is about 0·275.

Normal operating conditions

In a belt drive transmitting power under ordinary conditions the belt does not slip bodily over either pulley because the friction has not reached its limiting value at all points of contact. Experiments have shown that limiting friction exists at only a part of the arc of contact. This part extends backward from the point at which the belt leaves the pulley and subtends at the pulley centre an angle known as the "active angle". This angle has the same value for both pulley of a belt drive; so that if the active angle $= \beta$, then $T_1/T_2 = e^{\mu\beta}$ for each pulley. The change in the belt tension form T_1 to T_2 (or vice versa) takes place while the belt is passing over the region of limiting friction. There is a constant tension in that part of the belt which covers the remainder of the arc of contact.

Under these conditions, a correction must be made to the values of μ before using graphs such as those in Figs. 3 and 4. If the actual coefficient of friction between belt and pulley is μ then the graph to be used will be that corresponding to a value of the coefficient equal to $\mu(\beta/\theta)$ where θ is the total angle of lap.

Notes

(*a*) *Belt inertia.*—In the case of a belt drive running at speed, the effective tensions T_1 and T_2 which have been used in the analysis above, are smaller than the total tight side and slack side tensions respectively; the remainder is required to give the belt the necessary centripetal acceleration as it passes over the curve of the pulleys. The relevant relations then are:

$$T_1 = T_t - (wv^2/g)$$

and $$T_2 = T_s - (wv^2/g)$$

where T_t = total tight side tension
T_s = total slack side tension
w = weight of belt per unit length
v = belt speed.

(*b*) *Grooved pulleys.*—A belt running in a groove of included angle 2α with a coefficient μ is equivalent, for friction purposes, to a flat belt with the same angle of lap and a coefficient of friction equal to $\mu/\sin\alpha$.

New 204 hp Diesel Hydraulic Locomotive

Based upon their popular standard 204 hp diesel locomotive with mechanical transmission The Hunslet Engine Company Limited, of Leeds, have now introduced a carefully developed new model incorporating hydraulic transmission. This new locomotive is of 0-6-0 type with a weight in working order of 30 tons. It is powered by a Gardner type 8L3 diesel engine and "Hunslet" patent hydraulic transmission has been adopted in place of the four speed mechanical gearbox previously employed. By this means a starting tractive effort of no less than 20,700 lb is achieved with an attractive performance through two speed ranges up to a maximum of 12 mph. The torque converter is of a simple, single stage type, requiring virtually no maintenance. Designed for a relatively low torque multiplication it is capable of long continuous slow speed working with heavy loads. This feature, combined with the smooth starting characteristics of the hydraulic drive, makes the locomotive ideal for wagon weighing, hump shunting and other duties of this nature.

The driver is provided with a roomy, comfortable cab, which is mounted towards the centre of the locomotive. This, combined with the provision of generous window space, ensures first class all round visibility. The central position of the cab enables the floor to be completely flat giving unobstructed movement between the driving positions on either side. It also provides admirable maintenance accessibility, the engine and transmission being situated entirely within the two end compartments.

The controls, which are duplicated on both sides of the cab, are power assisted and are conveniently mounted on a desk facing the short end of the locomotive. They include a powerful straight air brake actuating cast iron brake blocks on all six wheels. Control of the train is not, however, solely dependent on the air brake, a converter/fixed drive control is provided so that use of the converter can be dispensed with at will and the full power of the diesel engine used to assist braking. Tests of Hunslet diesel-hydraulic locomotives in service have proved that the smooth operation of engine braking gives a vast reduction in stopping distances particularly under greasy rail conditions. This is of great importance in view of the immense loads which can be started by a diesel hydraulic locomotive where the initial tractive effort is limited solely by adhesion.

Hunslet 204 hp 0-6-0 type diesel hydraulic locomotive

Protection of Conductors Against Overheating

By J. L. WATTS

IN general, fires due to earth faults may occur owing to overheating of one or more conductors by the earth-fault current, the fusing of a conductor, or arcing between conductors at different voltages.

Heating of conductors

Heat is generated in any conductor which carries current, the rate of heat generation being proportional to I^2R, where I is the current (amperes) passing through the conductor, and R the resistance (ohms) of the conductor. The total heat generated in time t seconds is equal to I^2Rt Joules. The heating causes the temperature of the conductor to rise; with increased heat dissipation from the conductor, which tends to limit the temperature rise of the conductor if the current does not greatly exceed the normal rating of the conductor.

However, if an earth fault causes the current through any conductor greatly to exceed its normal rated value, the temperature rise may be so rapid that the conductor reaches a dangerously high temperature almost immediately. Each circuit should be protected by an over-current device, such as a fuse or overload circuit-breaker, which will automatically switch off the current if this reaches a dangerously high value.

Current ratings and cable protection

Column 3 of Table I gives the normal current rating of various sizes of cables when not more than two such single-core cables on d.c. or single-phase a.c. are bunched together or enclosed in one conduit, troughing or casing. Column 6 gives the current rating when three or four such single-core cables are bunched together or enclosed in one conduit, troughing or casing on a balanced three-phase a.c. circuit. For normal circuits the I.E.E. Regulations require that the current rating of the fuse should not exceed that of the cable, suitable sizes of fuses to satisfy these requirements being given in Columns 4 and 7 respectively. Where these normal circuits are protected by means of an overload circuit-breaker, the operating current of the breaker should not exceed twice the current rating of the cables, i.e., not more than twice the values given in Columns 3 or 6 respectively.

However, where overload releases in a motor starter provide protection against excess current in the motor and in the cables between the starter and motor, the rating of the fuse which protects the final sub-circuit supplying the motor may be up to twice the current rating of the cables on that final circuit. Suitable sizes of tinned-copper fuse wire for such circuits are listed in Columns 5 and 8 respectively.

Similarly, cables not more than two yards in length used for connecting switchgear may be protected by a fuse having a current rating up to twice that of the cables, as in Columns 5 or 8, or by an overload circuit-breaker set to operate at not more than four times the current rating of the cable.

A ring circuit wired with 7/0·029 cables (rated at 20 amp) to supply 13 amp socket-outlets, may be protected by a fuse rated up to 30 amp, such as one strand of 21 s.w.g. tinned-copper wire. The lower eight lines in Table I refer to flexible cords. In general, these should be protected by a fuse of rating not greater than

Table I.—SUGGESTED FUSES FOR CIRCUITS WIRED WITH SINGLE-CORE P.V.C.-, T.R.S.-, OR V.R.I.-INSULATED CABLES, AND FOR CIRCUITS USING FLEXIBLE CORDS TO B.S.7. AND B.S.2004

1	2	3	4	5	6	7	8
Nominal cross-sectional area of conductors (in²)	Number and diameter (in.) of cable wires	Current rating of each of two bunched cables on d.c. or single-phase	Normal number and size of protective fuse wires on d.c. or single phase	Maximum fuse for d.c. or single-phase motor sub-circuit with O/L releases	Current rating of each of three or four bunched cables on a balanced three-phase circuit	Normal number and size of protective fuse wires on a balanced three-phase circuit	Maximum fuse for a three-phase motor sub-circuit with O/L releases
		amps	Tinned-copper	Tinned-copper	amps	Tinned-copper	Tinned-copper
0·0015	1/0·044	5	1/35 s.w.g.	1/29 s.w.g.	5	1/35 s.w.g.	1/29 s.w.g.
0·002	3/0·029	10	1/29 ,,	1/23 ,,	10	1/29 ,,	1/23 ,,
0·003	3/0·036	15	1/25 ,,	1/21 ,,	13	1/26 ,,	1/22 ,,
0·0045	7/0·029	20	1/23 ,,	1/19 ,,	15	1/25 ,,	1/21 ,,
0·007	7/0·036	28	1/21 ,,	1/18 ,,	25	1/22 ,,	1/18 ,,
0·01	7/0·044	36	1/19 ,,	1/16 ,,	32	1/20 ,,	1/17 ,,
0·0145	7/0·052	43	1/18 ,,	1/15 ,,	39	1/19 ,,	1/15 ,,
0·0225	7/0·064	53	1/18 ,,	1/14 ,,	48	1/18 ,,	1/14 ,,
0·03	19/0·044	62	1/17 ,,		56	1/18 ,,	1/14 ,,
0·04	19/0·052	74	1/15 ,,		67	1/17 ,,	
0·06	19/0·064	97	1/14 ,,		88	1/15 ,,	
0·0045	7/0·029	20 amps	Current rating of fuse used on a ring circuit feeding 13 amp socket outlet = 30 amps. 1/35 s.w.g. tinned copper			Maximum size of tinned-copper fuse wire protecting the ring circuit = 1/21 s.w.g.	
0·0006	14/0·0076	2	in a distribution board	(When the flexible cord is used for a pendant)			
0·0006	14/0·0076	2	3 amp cart. in a plug				
0·001	23/0·0076	5	1/35 s.w.g.				
0·0017	40/0·0076	10	1/29 ,,				
0·003	70/0·0076	15	1/25 ,,				
0·0048	110/0·0076	20	1/23 ,,				
0·007	162/0·0076	25	1/22 ,,				

the current rating of the flexible cord, suitable sizes of tinned-copper fuse wire being given in Column 4. However, the I.E.E. Regulations permit 14/0·0076 flexible cord (rated at 2 amp) to be protected by a 3 amp fuse in a plug or, if used for a pendant, by a 5 amp fuse in a distribution board.

Fuses of current rating greater than that of the cable may also be used for certain minor circuits where the wiring is contained in earthed metal or non-ignitable insulating material.

Motor circuit cables

The starting current of an a.c. motor is usually much greater than the full-load running current, especially when started by direct-on-line switching. If the starting load is heavy so that the starting period is prolonged, this may necessitate using fuses of current rating greater than twice the full-load current of the motor. Table II gives suitable values of cartridge fuses for 415 volt three-phase motors, Column 3 referring to motors having direct-on-line starters, and Column 5 to motors having star-delta, auto-transformer or line-resistance starters, or to slip-ring motors. Since the current ratings of the fuses suggested for direct-on-line starters are more than twice the full-load current, the I.E.E. Regulations require the cables on the final sub-circuit feeding the motor to be not less than the values given in Column 4, even when overload releases are fitted in the starter.

It should be noted that the current in each of the six cables between a star-delta starter and motor is 58% of the line current input to the motor. The cables between the star-delta starter and motor may thus in general have a current rating of 58% of the full-load current of the motor, as in Column 7 of Table II. Comparing Columns 5 and 7 it will be seen that the current rating of the sub-circuit fuse may then be up to 333% of the rating of the cables between a star-delta starter and motor. However, if the overload releases in the motor starter are set to operate in the event of a sustained current 25% in excess of the full-load current of the motor, they will operate if an earth fault on a cable between the star-delta starter and motor causes the current in the cable to reach 220% of the cable rating.

Operating current of fuses

As will be seen later, earth faults may persist on a circuit if it is not properly protected by fuses, overload circuit-breaker or other means. In this section, however, we are concerned merely with the question of whether fuses or an overload circuit-breaker will prevent dangerous overheating due to an earth fault, which increases the normal current through a current-carrying conductor, and allows current to pass through the earth-continuity conductor. It will be seen that, with the exception of 14/0·0076 flexible cord used for pendants, each cable installed in accordance with the I.E.E. Regulations will be protected by a fuse rated at not more than twice the current rating of the cable, or an overload release operating on not more than about four times the current rating of the cable, provided that there are closely-set overload releases in each phase conductor of a motor starter. The latter stipulation is important. It can be taken that fuses will operate with a sustained current not more than twice the current rating of the fuse.

Table II.—SUGGESTED CABLES FOR VARIOUS 415 VOLT THREE-PHASE MOTOR SUB-CIRCUITS PROTECTED BY CARTRIDGE FUSES

1	2	Direct-on-line starting		Star-delta or resistance starting		
		3	4	5	6	7
Rated horse power of motor	Approx. full-load current in amps.	Rating of motor sub-circuit cartridge fuse with O/L releases in motor starter	Minimum current rating of motor sub-circuit cables	Rating of motor sub-circuit cartridge fuse with O/L releases in motor starter	Minimum current rating of motor sub-circuit cables	Minimum current rating of cables between a motor and star-delta starter
		amps	amps	amps	amps	amps
1	1·7	6	5	6	5	5
3	4·8	15	7·5	10	5	5
5	7	20	10	15	7·5	5
7½	10·5	30	15	20	10·5	6·1
10	13·5	35	17·5	25	13·5	7·8
20	26	80	40	50	26	15
30	39	100	50	60	39	22·6
40	52	160	80	80	52	30
50	64	160	80	100	64	37
75	95	250	125	160	95	55

Cable tests

Tests made some time ago indicated that 1/0·044 twin rubber-covered cable (rated at 5 amp) may catch fire when carrying seven times its rated current for just over an hour, or when carrying eight times its rated current for 15 min, or 18 times its rated current for about 35 sec. Covered cable, 3/0·029 p.v.c. (rated for 10 amp) fired when 5½ times its rated current was passed for 14 min, or when nine times the rated current was passed for 30 sec. Insulated cable, 3/0·029 V.R.I. (rated for 10 amp) caught fire when seven times its rated current was passed for 11 min, or when 10 times its rated current was passed for 90 sec.

When one of seven V.R.I. insulated cables in a short length of conduit was loaded up to 12 times its rated current, no fire occurred in the conduit, although there was a tendency for the wire to break near the terminals. Twenty-four times the rated current caused immediate ignition of the leading-in wires at the end of the conduit.

It will be appreciated that the insulation of cables may be seriously damaged, or short circuited, by heating which may not be sufficient to ignite the cables, but evidence appears to show that, provided cables are protected by fuses or overload circuit-breaker in accordance with Tables I or II, excess current, whether due to an earth fault or overload, will be cut off before it causes any risk of serious damage to a homogeneous current-carrying conductor.

However, in the event of there being a faulty connexion of high resistance in a conductor there may be a risk of excessive local heating at this point, or possible arcing, which might start a fire when earth-fault current flows. All connexions should, therefore, be maintained sound.

Fusing factor

It will be appreciated that the current through a fuse must exceed its current rating before the fuse can melt. The fusing factor of a fuse is equal to the ratio

$$\frac{\text{Minimum fusing current}}{\text{Current rating of fuse.}}$$

Fuses used to provide protection against relatively small but sustained over-currents may have a fusing factor as low as 1·25. Other cartridge fuses of the semi-enclosed type may have a fusing factor up to 1·75 or 2. Fig. 1 shows the inverse time-current curve for a fuse having a fusing factor of 1·25, and indicated the considerable time which may elapse before the fuse melts when carrying its minimum fusing current.

When a fuse carries current in excess of its minimum fusing current there is a short pre-arcing time during which the temperature of the fusible element rises to the

melting value, followed by a brief interval during which the arc is interrupted. The time lag of a fuse depends on various factors such as its construction, length, enclosure, size of fuse terminals, and ventilation; the time lag of different fuses may vary considerably.

On very high fault currents fuses have a current-limiting effect since they tend to cut off the current before it has reached its maximum or prospective value. The cut-off effect of a fuse is indicated in Fig. 2. An earth-fault current, however, can hardly reach the prospective value, even in the event of an earth fault at the consumer's main terminals, since the fault current will be somewhat limited by the impedance of the earthing circuit.

Time lag of circuit-breakers

The time lag of excess-current releases of a circuit-breaker, or the overload release of a starter, may also vary considerably, depending on the type of release and its setting.

One fusible-metal type of thermal overload release may operate in about 1½ min on three times its rated current, about 3 min on twice rated current, or about 30 sec on 6½ times its rated current. One bi-metal type of thermal overload release operates in about 3 sec on three times its rated current, about 8 sec on twice rated current, and about 0·1 sec on 40 times its rated current. A different make of bi-metal overload release operates in about 8 sec on three times its rated current, 20 sec on twice rated current, and about 1 sec on nine times the rated current.

The operating time of a thermal overload relay also depends on whether the relay has been heated up by normal load current prior to the occurrence of the excess current, as does the operating time of a fuse to some extent. Fig 3 indicates that one thermal overload relay operates in 130 sec if the current is maintained at twice its rated value when started from cold, or in 50 sec on twice rated current when running. The operating current required to trip the relay in 40 sec at starting may be as much as seven times the rated current.

Fig 4 indicates that a particular magnetic excess-current release with oil time-lag dashpot, when set at 25% overload, may operate in 10 sec on three times rated current (240% of setting), 20 sec on twice rated current (160% of setting) or in about 1 sec on 8·75 times rated current (700% of setting). The time lag depends on the setting, the grade of oil in the dashpots, and the temperature of the oil.

Provided they are correctly set in relation to the size of cable protected, and are maintained in proper working order, circuit-breakers and thermal overload releases can, however, be relied upon to protect a homogeneous current-carrying conductor against the risk of fire due to overheating resulting from an earth fault.

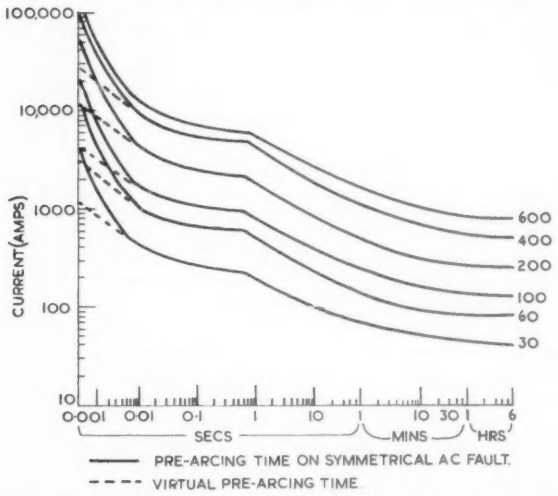


Fig. 1.—Time current characteristics of one make of dual-element cartridge fuse (fusing factor 1·25). The figures at right (from 30 to 600) are current rating of fuse (amps)

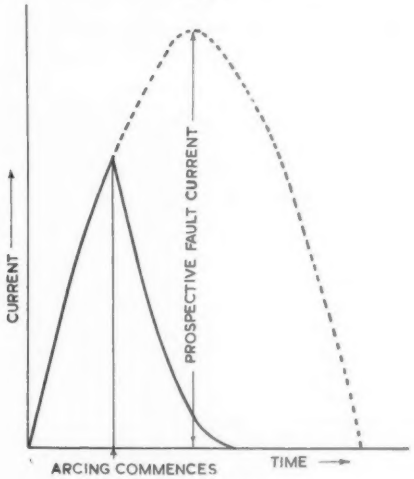


Fig. 2.—Cut-off effect of a fuse

Earth-continuity conductor

Where earthing of the exposed metalwork is required, the earth-continuity conductor used to connect the metalwork to earth may be wholly or in part the metal conduit or metal sheathing of the cables, an earth-continuity conductor contained in a cable or a flexible cable, or may be a separate conductor.

The Electricity Regulations of the Factories Acts require that the conductivity of the earthing conductors should not be less than half that of the current-carrying conductors of the system, with a minimum equivalent to 0·0045 sq in. (7/0·029) of copper. These Regulations point out that stranded cables are better mechanically in the smaller sizes than are solid copper and that, in some

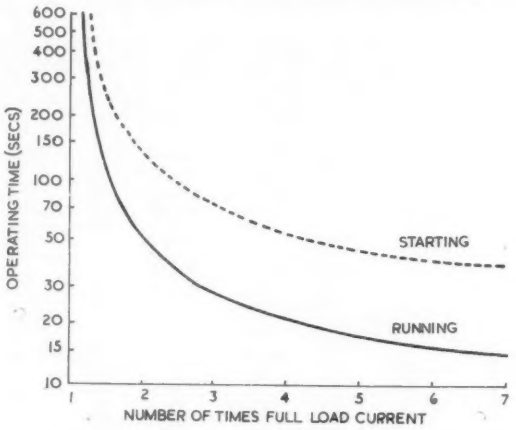


Fig. 3.—Characteristics of one type of thermal overload relay

cases, metal sheath or armouring of cables may require to be supplemented by an additional conductor in order to obtain the necessary conductivity.

The Coal and Other Mines (Electricity) Order, 1956, requires that any separate earthing conductor shall have a conductivity throughout (including any joint) not less than half that of the conductor having the greatest current-carrying capacity in relation to which it is provided, and shall have a cross-sectional area not less than 0·022 sq in. (7/0·064). These Regulations allow for an earthing conductor of not greater than 0·1 sq in. in a flexible cable used to feed portable apparatus at not more

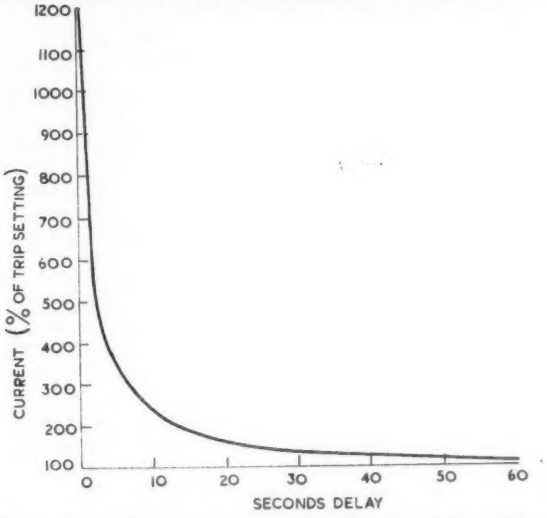


Fig. 4.—Characteristics of a magnetic excess-current release with oil time-lag dashpot

than 125 volts; whilst the cross-sectional area of an earthing conductor used in a flexible cable feeding portable apparatus of not more than 3 kW at the surface of the mine need not exceed that of any of the other conductors of that flexible cable.

The Quarries (Electricity) Order, 1956, requires that every separate earthing conductor shall have a cross-sectional area of not less than 0·022 sq in. and each flexible cable shall incorporate an earthing conductor having a cross-sectional area and conductivity not less than that of the other conductor of greatest current-carrying capacity in the cable.

The "Regulations for the Electrical Equipment of Buildings" issued by the Institution of Electrical Engineers (The I.E.E. Regulations) require that, in the case of an earth-continuity conductor not contained in a composite cable, its cross-sectional area shall, in general, be not less than half that of the current-carrying conductor, and in no case less than 0·0045 sq in. (7/0·029) although no earth-continuity conductor need be larger than 0·1 sq in. The impedance of the earth-continuity conductor from the consumer's earthing terminal to any point on the exposed metalwork should normally not exceed one ohm, although lower values may be required for circuits of high current rating at low and medium voltage. All these regulations require that flexible metallic conduit shall not, by itself, be used as the earth-continuity conductor.

Protection of the earth-continuity conductor

The various regulations relating to the size of the earth-continuity conductor are designed to ensure that, under normal conditions where a circuit is properly protected, any earth-fault current will be cut off by the excess-current device before it can result in dangerous overheating of the conductor. For instance the I.E.E. Regulations permit the use of a separate earth-continuity conductor of not less than 0·007 sq in. (7/0·036) for the exposed metalwork of a circuit fed through conductors of 0·0145 sq in. The fusing current of such an earth-continuity conductor may be in the region of 320 amp; whilst the fuse required to protect a cable of 0·0145 sq in. should normally have a current rating of 34 to 43 amp. If such a cable were used on a final sub-circuit supplying a motor, having overload releases in the starter, the fuse might be rated up to 86 amp. However, even a fuse of this size would melt at about 170 amp and thus should cut off the current before dangerous overheating of the earth-continuity conductor occurs, particularly if load current, as well as earth-fault current passes through the fuse.

Table III shows that, in all cases the size of earth-continuity conductor required in a flat twin tough-rubber sheathed or p.v.c.-sheathed cable is no less than half that of each current carrying conductor of the cable. Whilst a 1/0·044 bare copper wire might require about 80 amp to melt it, tests have shown that a 1/0·044 twin rubber-covered cable caught fire when a prolonged current of 35 amp was passed through it. A 1/0·044 earth-continuity conductor may be used in a flat twin T.R.S.-sheathed cable rated at 15 amp. which is normally protected by a fuse rated at 15 amp. However, if such a cable is used on a final sub-circuit feeding a motor it may be protected by a fuse rated at 30 amp, and this may fail to melt on a prolonged current of 35 amp. It is possible that on such a circuit the earthing conditions may be such as to allow a dangerously high earth-fault current to flow through the earth-continuity conductor without the fuse melting, if no load current were passing through the fuse at the same time.

On a small motor circuit it would appear, therefore, that the use of a separate earth-continuity conductor complying with I.E.E. Regulations is preferable to one in such a composite cable. It will, of course, be realised that there may be a fire hazard due to a high resistance connexion in an earth-continuity conductor; or in the event of the fuse being too large, the over-current setting of a breaker being too high, or the protective release of the breaker being inoperative.

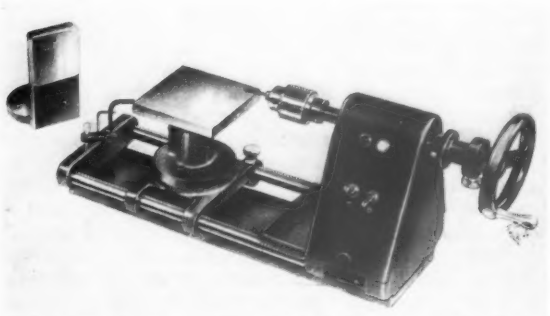
Table III.—SIZE OF EARTH-CONTINUITY CONDUCTOR IN METAL-SHEATHED, TOUGH-RUBBER-SHEATHED AND P.V.C.-SHEATHED CABLES (I.E.E. REGULATIONS)

Size of current-carrying conductor		Size of wires forming earth-continuity conductor			
		Flat twin and flat three-core metal-sheathed cables		Flat twin tough-rubber sheathed and p.v.c.-sheathed cables	
1	2	3	4	5	6
Nominal cross-sectional area	Number and diameter (in.) of wires	Approximate cross-sectional area of earth-continuity conductor	Number and diameter (in.) of wires	Approximate cross-sectional area of earth-continuity conductor	Number and diameter (in.) of wires
sq in.		sq in.		sq in.	
0·0015	1/0·044			0·0015	1/0·044
0·002	3/0·029	0·001	1/0·036	0·0015	1/0·044
0·003	3/0·036	0·0015	1/0·036	0·0015	1/0·044
0·0045	7/0·029	0·0015	1/0·044	0·003	3/0·036
0·007	7/0·036	0·0015	1/0·044	0·0045	7/0·029
0·01	7/0·044	0·002	1/0·052	0·007	7/0·036
0·0145	7/0·052	0·003	1/0·064	0·01	7/0·044
0·0225	7/0·064	0·004	1/0·072	0·0145	7/0·052

Versatile Tapping and Reamering Machine

The new "Andytap" is a versatile, sensitive, hand operated bench machine designed for accurately tapping and reamering small components such as pressings, stampings, brass and aluminium castings, mouldings and machine parts in the instrumentation, electronics and mechanical engineering fields. It is solidly constructed, simple to use and easily and quickly set for right- or left-hand threads. A two-light signal system (caution and stop) is incorporated for tapping blind holes or where a tap has to go to a required depth. These lights are battery operated and can be used independently, or a loose collar can be locked for rotary work without using the lights. Capacity is up to No. 0 B.A. in steel, ¼ in. Whitworth in non-ferrous material, and up to ¼ in. reamers. Its equipment includes angle plate, tool post, adjustable table, ¼ in. chuck and operating keys, at £33. 15s. 0d. complete.

The machine is distributed in U.K. by Monks & Crane Limited, Machine Tool Division, Garretts Green Lane, Birmingham 33.



The Andytap tapping and reamering machine is hand operated and has a two-light indicator for tapping to depth

Shock and Abrasion Resistant Conveyor Belt

Analyses of failures over many years show that much of the trouble experienced with conveyor belting is attributable to shortcomings of the weft yarns in the fabric which give the belt its transverse strength. Rarely is the longitudinal strength, derived from the warp yarns, found to be wanting. Appreciation of these fundamental facts underlies the design of a new belt produced by George Angus & Co. Limited, 152-8 Westgate Road, Newcastle upon Tyne. Named "Gaflex", the new belt has cotton warp yarns, of proved reliability, woven with strong and resilient nylon weft yarns.

Nylon is noted for its strength and elasticity, both of which are approximately four times greater than cotton, bulk for bulk. By attention to the details of fabric design it has been possible to increase the warpway strength by 25% so that four plies of the new fabrics are equal in strength to five conventional fabric plies.

The new construction results in a belt which has exceptional resilience. This has a number of advantages, in particular it endows the belt with a superior resistance to shock, tear resistance, improves troughing characteristics, a longer flexing life and improved fastener holding.

The belt is being made in three types: Gaflex "Standard", "Super", and "Plus". Gaflex Standard embodies a carcase built from standard nylon/cotton plies, proofed and bonded with rubber compounds to produce a supple carcase with strong interply adhesion, covered with a general purpose cover compound. This quality is particularly suitable for use on coal conveyors, in gas works and electricity generating stations, or in sand and gravel quarries, clay pits or brickworks, or wherever durability is required when abrasive wear on the cover is not a severe problem.

Gaflex Super is built from the same carcase components as Gaflex Standard, but is covered with a newly developed rubber compound which imparts toughness, tear strength, abrasion and cut resistance. With this resilient armouring, Gaflex Super belting is eminently suitable for the toughest duties on coke, rock and ore conveyors where a high degree of gouging, cutting and impact resistance is necessary.

In Gaflex Plus the carcase is similar to Gaflex Standard and is assembled with insulating layers of rubber between the plies to enhance flexibility and produce an interply bond of high strength. The cover compounds used provide durability to match the wear resistance of the carcase. As a result, Gaflex Plus is suitable for conveyors where highly abrasive loads are carried, and where high flexing stresses are imposed on the belt.

Gaflex belting is built in the usual carcase constructions of straight ply for all general purposes, stepped ply for applications where severe cover wear occurs in a localized central strip, and breaker strip as an addition to either of the above constructions for belts which are to handle large lumps of heavy material.

Nylon is inherently proof against mildew attack and to render the cotton warp component also proof against ravages, Gaflex belting can be supplied treated with an effective anti-fungicidal chemical which inhibits bacteriological development.

Small-bore Measuring Equipment

Small-bore measuring equipment introduced by Hilger & Watts Limited, 98 St. Pancras Way, London NW1, for attachment to a Microptic Horizontal Measuring Machine TL.10 (metric scale machine TL.11) is designed to measure small-bores from 0·04 in. to 0·5 in. (1 to 12·7 mm) in diameter, to an accuracy of 0·00005 in. (0·001 mm).

The equipment consists of an arm carrying a probe, a cross-traverse work-table fitted with a micrometer which reads to 0·001 in. and a mains-operated electrical unit which controls a magnetic brake device attached to the measuring plunger of the machine.

To measure a bore, the arm is attached by a spigot and threaded ring to the machine's measuring plunger, with the probe in a vertical position. The work-piece is clamped to the work-table which is then raised so that the probe enters the bore. The measuring plunger is then moved longitudinally until the probe makes electrical contact with the wall of the bore, which causes the magnetic brake to be applied, thereby "locking" the plunger and preventing further movement. The reading appearing on the ground-glass viewing screen of the machine is noted. The brake is released by a push-button switch and the plunger is then moved in the reverse direction until the probe makes contact with the opposite wall of the bore, when the brake is re-applied. The diameter of the bore is the difference between the two readings obtained.

To ensure that the true diameter across dead centre has been measured, several pairs of readings are taken

with the work-table set, by means of the micrometer, in various cross-traverse positions. The highest difference in readings is the true diameter.

A dial indicator for measuring the depth of the probe in the bore is also available.

Co-ordinate Inspection Machine

A new co-ordinate inspection machine which provides a rapid means of inspection of machined work-pieces to an accuracy of 0·001 in. has been introduced by Ferranti Limited, Hollinwood, Manchester. Similar electronic techniques to those used in the highly successful Ferranti machine tool control systems have been applied to the design of this machine—claimed to be the only one of its type in the world—for at the outset of research work two years ago, these techniques were the obvious solution to the inspection problem.

When comparing inspection of a work-piece on this machine with conventional inspection methods using dial gauges, etc., a very significant saving in time can be effected, resulting in increased output of inspection departments. The operator has under his control an inspection probe with interchangeable tips suitably shaped to locate at any point on a machined part. This probe is supported from a rigid cantilever beam projecting over the work-table, and is free to move over the length and breadth of the table.

Low friction bearings provide a minimum of resistance to movements in both x and y directions, the maximum travel of the probe in the x direction being 24 in. and in the y direction 15 in. Travel in the vertical direction, which at the moment is not used for measurement, is 10 in. and the probe is spring-loaded towards the upper limit of travel. Electro-optical sensing units are fitted to the x and y axes of the machine. Motion along either axis, causes the Moiré fringe pattern generated by associated diffraction gratings to traverse photocells, where changes in light intensity are converted into their electrical counterpart. Transistor bi-directional decade counters (one for each axis) record the cyclic variation.

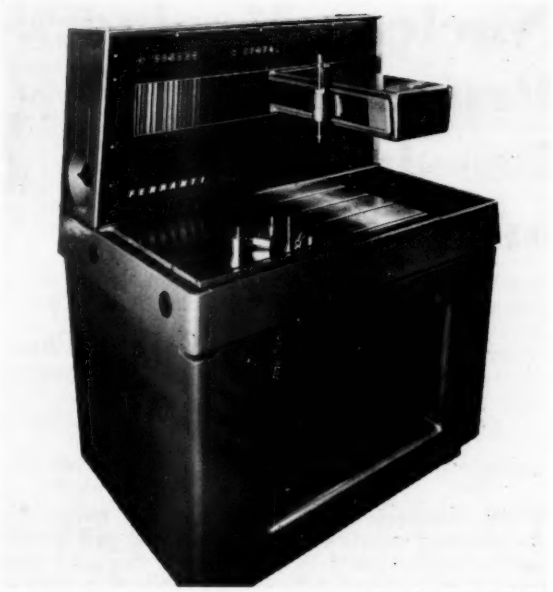
As information of measurement is displayed continuously on two five-figure electronic counter banks, the position of the probe at any point in its x and y travel can be read-off directly to an accuracy of 0·001 in. or 0·02 mm.

The basic price of the machine is about £2,200.

250g Accelerometer

A new accelerometer which weighs only 20 gm should be useful to meet the demand for a light weight high sensitivity transducer capable of measuring shock and vibration in guided missiles, aircraft, packaging and for general purpose use. Piezo-electric ceramic material TCL3, which is utilized in the new accelerometer, has a wide temperature range from $-40°$ C to $+80°$ C, low temperature coefficient and long term stability. The accelerometer has a high sensitivity of 80mV/g with a capacity of 1·000 pf, thus enabling measurements to be made down to a few cycles/second when used with a cathode follower of 1000 M input impedance.

Three feet of special low noise cable is supplied with the unit, connection being made via a subminiature plug and socket which isolates any cable whip from exciting the piezo-electric element. Owing to the high capacitance of the accelerometer, longer lengths of cable may be used without reducing the sensitivity to any great extent.



Ferranti co-ordinate inspection machine, the first of its type in the world, provides a rapid means of inspection of machine work-pieces to an accuracy of 0·001 in.

The transducer has a linear output over the acceleration range 0·01 to 250 g and the transverse sensitivity is less than 5% in any direction. Individual calibration is made over the range 20 c/s—800 c/s. Sealed construction permits operation in conditions of high humidity.

The instrument is a product of Technical Ceramics Limited, Wood Burcote Way, Towcester, Northants.

New Plastics Coating is Machinable

The many useful physical properties of plastics materials make them admirable as constructional materials, especially where resistance to various forms of chemical or organic attack is required. As a coating on metallic parts their use results in a combination of the strength and economy of the metal with the resistance of the plastics. In January of this year the Plasinter process for coating ferrous and non-ferrous metals in this way was introduced, and the succeeding months have shown considerable developments in the types of coating and in the variety of their application. In particular a new coating, Plasinter HG, is highly resistant to chemicals, is non-porous, a non-conductor of electricity, resistant to oil, grease and petrol, has a non-chipping surface and good bending properties, has a hard high gloss surface, is unaffected by ultra-violet light, and can be machined and drilled. The material can therefore be added to, say, a casting or wrought part and then machined on surfaces where accurate fitting is required, while all the time preserving the protective coating.

The process is carried out by the Plastinter Division of Darlaston Galvanised Halloware Limited, Progress Works, Holyhead Road, Wednesbury, Staffordshire.

Nuclear Marine Propulsion in Russia, France and Japan

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

THE development of nuclear-powered naval and merchant vessels in U.S.A. during the past decade was recently reviewed in this journal. Engineers and scientists in other parts of the world are actively engaged in the preparation of projects on nuclear marine propulsion. In some countries the delay between the design study or the pilot plant stage and the full-scale commercial application is rather great.

Although technical progress in some countries is relatively slow and in some instances less impressive than in U.S.A., nevertheless there is real justification for directing special attention to the following three major projects:

(A) The U.S.S.R. Ice Breaker *Lenin*.
(B) French design studies on a submarine and an oil tanker.
(C) Japanese proposals for a submarine tanker, an emigrant ship, a merchant ship and an oil tanker.

The primary aim of this contribution is to consider the most important design features and to summarize concisely the essential particulars, by presenting a series of tables. This information is based on separate papers on the three subjects submitted to the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, held at Geneva in September, 1958.

A. The U.S.S.R. Ice Breaker *Lenin*

There is no doubt that Russia can claim that the *Lenin*, built at Leningrad Shipyard, is not only the first nuclear-powered ice breaker but also the largest and fastest ice breaker in the world. Her power plant comprises three pressurized light water-moderated and cooled reactors (which includes one as a spare), six heat exchangers, four d.c. main generators driven by steam turbines through single reduction gearing, and three d.c. motors, each driving a propeller. The maximum rating of all the four turbines is 44,000 hp. The specific total rating is 2·75 hp/ton displacement. A summary of the particulars is indicated in Table I.

1. General details of propulsion plant

A distinctive feature is the turbo-electric propulsion system with double wound armature for both the main generators and motors. Each main turbine, consisting of a single casing, drives through a single reduction gear two double wound armature d.c. generators of 3840 kW

Table I.—SUMMARY OF THE PARTICULARS OF THE U.S.S.R. NUCLEAR POWERED ICE BREAKER *LENIN*

The plant consists principally of three reactors with six heat exchangers, four turbine geared driven d.c. main generators, and three d.c. main motors driving the three propellers.

1.	Date of commencement at the Leningrad Shipyard	August 25, 1956
2.	Date of launching	Dec. 5, 1957
3.	Date of mooring trial tests	Feb. 12, 1959
4.	Date of commissioning	1959
5.	Total displacement	16,000 ton
6.	Main dimensions: length	134m = 439·5 ft
	width	27·6m = 90·53 ft
	height midship	16·1m = 52·81 ft
	draught	9·2m = 30·18 ft
7.	Total rating of the turbines at top speed of the reduction gears	44,000 hp
8.	Specific total rating per ton displacement	2·75 hp/ton
9.	Maximum speed of ice breaker in clear water	18 knot
10.	Cruising speed of the ice breaker in ice of 2·4m = 7·87 ft thick	2 knot
11.	Number of propellers	3
12.	Speed of propellers:	
	(a) centre	185 rpm
	(b) both outboard	205 rpm
13.	Weight of electrical and mechanical power plant (including propulsion motors and power plant, but excluding nuclear plant)	2750 ton
14.	Weight of nuclear power plant (including biological shield)	3017 ton
15.	Total weight of propulsion plant	5767 ton
16.	Specific total weight of propulsion plant per hp	290 ton/hp
17.	Weight of biological shield	1963 ton
18.	Main generating plant:	
	(a) No. of main turbines	4
	(b) No. of main d.c. generators	8
	(c) No. of main gears (single reduction)	4
	(d) No. of d.c. generators per main turbine	2
	(e) max. rating of each d.c. generator	3840 kW
	(f) max. rating of the two d.c. generators per turbine	7680 kW
	(g) total maximum rating of eight d.c. generators driven by four main turbines	30,720 kW (41,250 hp)
	(h) combined voltage of d.c. generators (2 × 600)	1200 volt
	(i) speed of generators	595 rpm
19.	Main turbines:	
	(a) No.	4
	(b) No. of cylinders per turbine	1
	(c) steam pressure at turbine stop valve	398 psi
	(d) steam temperature at turbine stop valve	590° F
	(e) steam quantity through turbine stop valve	112,400 lb/hr
	(f) total steam for four main turbines	449,600 lb/hr
	(g) feed temperature	212° F
20.	Auxiliary turbo-generators:	
	(a) No. of sets	3
	(b) rating of each set	2100 kW
	(c) total rating of three sets	6300 kW
	(d) steam pressure at the exhaust of the auxiliary turbines	28·4 psig
21.	Motors for driving the propellers:	
	(a) No. (one for each propeller)	3
	(b) rating of each d.c. motor	
	(1) centre propeller (twice the outboard propeller)	19,600 hp
	(2) each outboard propeller	9800 hp
	(c) total rating of the three motors	39,200 hp
	(d) voltage of the d.c. motors	1200 volt
22.	Reactors:	
	(a) No. (includes one standby)	3
	(b) steam output from two reactors	528,960 lb/hr
	(c) steam output from three reactors	793,440 lb/hr
	(d) type of reactor	PWR
	(e) pressure of water in the reactor	2844 psi
	(f) heat rating of each reactor	90,000 kW
	(g) heat rating of two reactors	180,000 kW
	(h) fuel	sintered uranium dioxide
23.	Reactor core:	
	(a) outside diameter	39·37 in.
	(b) height	63·00 in.
	(c) weight of sintered uranium dioxide	187·3 lb
	(d) type of fuel element	rod
	(e) canning material for the fuel elements	zirconium alloy
	(f) material of the control rods	natural mixture of boron isotopes
	(g) highest temperature of fuel in centre of the rod	1832° F
	(h) temperature of water at inlet to reactor	478° F
	(i) temperature of water at outlet from reactor	617° F
	(j) temperature rise of water in reactor	139° F
	(k) volume of water flowing through each reactor	35,315 cu ft/hr
24.	Reactor vessel:	
	(a) type	vertical and cylindrical
	(b) outside diameter	6·56 ft
	(c) height	16·40 ft
	(d) material	low alloyed high tensile carbon steel
	(e) inner cladding	stainless steel
25.	Heat exchangers:	
	(a) No. for each reactor	2
	(b) total for three reactors	6
	(c) steam pressure at outlet	412·4 psi
	(d) steam temperature at outlet	590° F
	(e) volume of water flowing through each heat exchanger	17,657 cu ft/hr
	(f) heat transfer surface of one heat exchanger	4036·5 sq ft
	(g) capacity of main circulating pump for each heat exchanger	17,657 cu ft/hr
	(h) power required for each main circulating pump	250 kW
	(i) head of pump	328 ft

each, arranged in parallel. Therefore, the total rating of each main turbine amounts to 7680 kW and the grand total for the four main turbines corresponds to 30,720 kW, i.e., 41,250 hp. The speed of these generators is 595 rpm.

It is of interest that each main turbine unit has one d.c. generator of the double wound armature type with the windings connected permanently in parallel to give a total of 3840 kW at 1200 volts. Four of these generators supply the current to the main motor driving the centre propeller. In the case of other d.c. generators of the main turbine unit each of the windings of the armature supplies separately 1920 kW at 600 volts. Four such 1920 kW per armature windings are in circuit with each main propulsion motor of the outboard propellers.

The propulsion motors with double wound armatures are rated so that the centre propeller transmits twice the power of each of the outboard propellers. Consequently the output of these motors is 19,600 hp at a propeller speed of 185 rpm and 9800 hp at 205 rpm respectively, representing a total of 39,200 hp for the three propellers.

The system provides a comparatively simple supply to the three motors from four turbine-driven generator units, and has the additional advantage of distributing the generating capacity to the three propeller shafts in the ratio of 1:2:1. This arrangement ensures that 75% of the power is available, should, for instance, a breakage occur to the propeller blades of one of the outboard screws. It is claimed that for the first time in shipbuilding practice a d.c. voltage of 1200 volts has been applied.

A special feature of the single casing turbine is the elimination of the intermediate reduction gear, thus having the desired advantage of decreasing the number of bearings. Although slightly less efficient, it is simple, provides larger axial clearance for the reaction blading and is therefore more reliable. From the point of view of simplicity, throttle governing has been selected for the main steam turbines. The steam conditions at the turbine stop valves are 398 psi and 590° F, and the steam flow through each main turbine is 112,400 lb/hr. Further data on the power and the propulsion plants, and on the auxiliary turbo-generators is included in items 18 to 21 of Table I.

2 Reactors

The reactor is of the pressurized light water-moderated and cooled type. This was a very wise decision. The first application of such a reactor to marine propulsion was carried out in 1951 with the construction of the land-based prototype for the U.S. submarine *Nautilus* at the National Reactor Research Station. It is of particular importance to add at this stage that the contract for the *Nautilus* was placed in 1952 and it was in commission on January 17, 1955, which is about 19 months before the commencement of the *Lenin* at the Leningrad Shipyard on August 25, 1956. This indicates that the Americans were pioneers in the design, the construction and the operation of the pressurized light water reactor and that U.S.S.R. are taking an active interest in this type for marine propulsion.

Table II.—COMPARATIVE PARTICULARS OF NUCLEAR AND DIESEL ICE BREAKERS

			Lenin	*Glacier*
1.	Ice breaker		nuclear-turbo-electric	diesel-electric
2.	Type of propulsion			
3.	Length of vessel	ft	439·5	310
4.	Total power	hp	44,000	21,000
5.	No. of propellers		3	3
6.	Speed of the propellers	rpm	185/205	120/175
7.	Total number of turbo-generator sets		4	—
8.	Total number of diesel-generator sets		—	10
9.	Maximum rating of each turbo set	kW	7680	—
10.	Maximum rating of each diesel set	kW	—	1890
11.	Specific total rating per ton displacement		2·75	2·2

The essential particulars and the design data relating to the reactor, the core, the vessel and the heat exchangers are summarized in Table I, items 22 to 25 inclusive. There are three reactors, one being a standby. The heat rating of each is 90,000 kW so that the total heat rating required for the maximum power of 44,000 hp is 180,000 kW. The steam output from two reactors amounts 528960 lb/hr. The pressure of the water in the reactor is 2844 psi, whilst in U.S.A. plant this value is generally about 2000 psi (normal) and 2500 psi (maximum). Each reactor has two heat exchangers, so that the total is six. The core is designed to operate at the maximum rating for a year. This enables the ice breaker to be in service a few years without refuelling. The core can be reloaded, either channel after channel, or completely.

3. Some comparative data on the U.S.S.R. *Lenin* and the U.S. *Glacier*

It is interesting to compare the characteristics of the nuclear-turbo-electric *Lenin* and the diesel-electric *Glacier* which is the U.S. Navy's largest ice breaker. She faced her first polar ice in the winter of 1955/56, when she sailed to the Antarctic. She was built by the Ingalls Shipbuilding Corporation, Pascagoula, Mississippi. The information relating to these two ice breakers is indicated in Table II.

The U.S. *Glacier* has two propulsion motors of the double wound armature type. Such motors have been installed in the U.S.S.R. *Lenin*. The specific total installed rating, expressed in horse power per ton displacement, of the *Lenin* exceeds that of all other ice breakers. Therefore she will be able to penetrate through thicker icefield than any other modern ice breaker.

B. France

It is significant that eminent French physicists pioneered the earlier fundamental researches which formed the basis of a series of original investigations that ultimately directed attention to an intensive study and the useful development of nuclear energy. Historical record reveals that Antoine Henri Becquerel (1852–1908) discovered radioactivity in 1896, and Pierre (1859–1906) and Marie Curie (1867–1934) isolated radium from pitchblende in 1898.

Sponsored by the Commissariat a l'Énergie Atomique and the Électricité de France, a fairly large number of experimental, plutonium producing and power reactors have been commissioned, others are under construction or in the process of being designed. In addition plans have been made, about two years ago, for the building of an isotope separation plant for the production of enriched uranium. Furthermore, a project is in hand in the Pyrenees for the manufacture of heavy water by electrolysis. There are seven large research establishments, four close to Paris and three further south. Over 7000 employees, which includes about 1300 nuclear scientist designers and engineers, are engaged in France's research and development projects. The principal centres are at Chatillon and Saclay, near Paris and at Grenoble, which has only recently been established and is to be closely associated with the university there.

France's first pile was in operation at Chatillon in December, 1948. It was known as ELI or "Zoe" and was of the heavy water moderated and cooled type, the initial power being 5 kW. Natural uranium was used for

the fuel. Since then "Zoe" has been modified considerably and the output has increased to 150 kW. It is interesting to recall that Britain's first pile, the "Gleep" (Graphite Low Energy Experimental Pile) was started up at Harwell on August 15, 1947, and about 18 months earlier than the French "Zoe". Up to to 1959, France has operated nine experimental and two plutonium power reactors. The latter are of the graphite-moderated and gas-cooled type and are installed at Marcoule, near Avignon on the Rhone, and designated G1 and G2. A third reactor G3, identical with G2, is to supply electricity towards the end of 1959. Like Calder Hall and Chapelcross the G1, G2 and G3 are dual purpose reactors specially designed to produce plutonium for defence and steam for turbo-generators.

In addition, the Électricité de France have under construction two power reactors and are considering installing a third at a later date. These are to be located at Avoine on the left bank of the Loire, about six miles from the town of Chinon. The projects are known as EDF1, EDF2 and EDF3, the capital letters corresponding to the abbreviation of "Électricité de France". These power reactors are of the graphite-moderated and gas-cooled type similar to those in Great Britain. EDF1 is to be partially of an experimental character whilst EDF2 will be the prototype for future nuclear power stations. The fuel is natural uranium and the coolant is high pressure carbon dioxide. The EDF1 is to be started up in the autumn of 1959 and EDF2 about 18 months later. Project EDF1 consists of one reactor, having a heat rating of 300 MW, one heat exchanger, one turbo-generator, designed for a maximum output of 82 MW and one gas circulator, driven by two constant speed motors, each with a nominal power input of 5135 kW and an output at the coupling of 4930 kW. The turbine operates on the dual-pressure system, has two inlets for each supply of steam, a total of 26 stages and two double flow L.P. cylinders, therefore four L.P. exhausts. There are two feed heating stages. In size, such a turbine compares with a conventional 250 MW, operating at high steam conditions with reheating. The net electrical output of EDF1 is 60 MW, which corresponds to an overall thermal efficiency of 20%.

In the EDF2 plant the heat rating of the reactor will be about 750 MW and the net electrical output 167 MW. There are two turbines, each designed to give a maximum output of 125 MW. The pressure of the carbon dioxide, used for cooling the reactors, has increased from 213·3 psi for G1, G2 and G3 at Marcoule to 355·3 psi for EDF1 and EDF2 at Avoine. The general particulars of these nuclear power plants are summarized in Table III. France's progress in her nuclear extension programme during the past few years can be judged primarily by her annual output of plutonium, which is expected to be about 220 lb. In order to assess the importance of plutonium for defence purposes one has to bear in mind that 20 to 30 lb are required to make a bomb. A further testimony to her nuclear achievements is the supply of electricity to the French grid, which began on April 22, 1959, with the commissioning of reactor G2 at Marcoule. Therefore, France was second in West Europe, Great Britain being first, to produce electricity commercially from nuclear power. Calder Hall nuclear power station, officially started on October 17, 1956, was the first.

1. The nuclear-powered submarine

As in Britain, progress with France's nuclear-powered submarine Q244 has been slow. The announcement of its construction was made about July, 1958. It was also stated that she would be completed in about four years, i.e., in 1962. Her displacement is expected to be 5000 tonnes, which is about 50% greater than the U.S. *Nautilus* and nearly as large as the U.S. *Triton*. These comparisons are based on the standard (surface) displacements. The nuclear-powered submarine *Triton* is so far the largest of the U.S. Navy. Her light, standard (surface) and submerged displacements are 5650, 5900 and 8000 tons respectively. In the original project the reactor of the Q244 was to be of the heavy water moderated and cooled type, having natural uranium as the fuel. The selection of this type was based on experience with five such experimental reactors during the years 1948 to 1957.

However, after nearly a year of design study and in the construction of the heavy water reactor for their first nuclear-powered submarine, French engineers decided, about May, 1959, not to proceed with this type. The primary reason came as a result of negotiations that have been in progress for some time between France and the United States. The main object of the discussions was to reach agreement on the exchange of design and technical information. Consequently the original plan for using natural uranium rather than enriched uranium had to be abandoned. This seems to indicate that a pressurized light water-moderated and cooled reactor is to be installed. It is understood that construction on this revised project is to start this year. In accordance with the agreement, the United States has arranged to sell to France during the next ten years up to 970 lb of enriched uranium, 660 lb enriched to 90% and the remainder to 20%. The keel of France's first nuclear-powered submarine was

Table III.—PARTICULARS OF GRAPHITE-MODERATED AND GAS-COOLED REACTOR PLANTS IN FRANCE

1	2	3	4	5	6	7
	Location		Marcoule		Avoine	
Item	Project	Unit	G1	G2 & G3	EDF1	EDF2
1.	Date of operation		7.1.56	21.7.58 (G2) 1958 (G3)	1959	1960
2.	Thermal rating of reactor	MW	40	150	300	750
3.	Gross electrical output	MW	*5·75	40		
4.	Net electrical output	MW	nil	30	60	167
5.	No. of turbines		1	1	1	2
6.	Maximum rating of each turbine	MW	*5·75	40	82	125
7.	Total maximum rating of turbines at 3000 rpm	MW	*5·75	40	82	250
8.	Maximum rating of each generator	MVA	*7·187	45	117·5	
9.	Power factor		0·8	0·89	0·7	
10.	Voltage of generator	volt	5500	10,500	14,500	
11.	Steam condition at T.ST.V.					
	(a) H.P. pressure	psia	99·5	149·3	307·2	
	(b) L.P. pressure	psia	—	31·3	61·2	
12.	Steam flow at T.ST.V.					
	(a) H.P.	lb/hr	54,500	378,630	633,161	
	(b) M.P.	lb/hr	—	52,286	234,858	
	(c) total H.P. and M.P.	lb/hr	54,500	430,916	858.019	
	(d) H.P. as % of total (c)	%	100	87·86	73·79	
13.	Steam temperature at T.ST.V.					
	(a) H.P.	°F	327	633		
	(b) L.P.	°F	—	340		
14.	Vacuum at turbine exhaust at 30 in. Hg barometer	in. Hg	29·00	29·00	29·00	
15.	Final feed heating temperature	°F	80·6		110	
16.	No. of feed heating stages		none		2	
17.	No. of stages in the turbine		14		17	
18.	Arrangement of the stages					
	(a) H.P.		6		1+9	
	(b) M.P.		5		4	
	(c) L.P.		3		(4×3)	
19.	No. of flows at turbine exhaust		1		4	
20.	Coolant used for the reactor		air	CO_2	CO_2	CO_2
21.	Pressure of coolant	psi	atm.	213·3	355·5	355·5

* Arrange vertically with the H.P. above and L.P. below to facilitate removing the moisture from the turbine.

laid at Cherbourg at the beginning of 1958. It is significant that both Great Britain and France had to revise their original ideas on the selection of the submarine reactor. It was wise to grasp the opportunity offered to them by the United States for design and technical information, coupled with operating experience. In addition, such an agreement reduces research and development costs and has the desired advantage of expediting the completion of the submarine.

2. Nuclear-powered oil tanker

In 1956 the French Merchant Marine and Atomic Energy Commission commenced an investigation into the possibility of applying nuclear power to the propulsion of merchant vessels. The primary object was to make preliminary design studies on the suitability of three types of reactors for an oil tanker.

Table IV.—NUCLEAR POWERED OIL TANKER

SCHEME A

PRESSURIZED LIGHT WATER-MODERATED AND COOLED REACTOR

1. Reactor:	
(a) No.	1
(b) fissile material	uranium oxide enriched to 1·5%
(c) weight of fissile material	8 tonne
(d) No. of fuel assemblies	272
(e) No. of fuel rods per assembly	25
(f) total number of fuel rods	6800
(g) diamter of fuel rod	0·3937 in.
(h) length of fuel rod	59·05 in.
(i) material for the fuel cans	zircaloy or stainless steel
(j) diameter of the complete fuel assemblies	63·86 in.
(k) No. of control rods (cross-shaped)	21
(l) material of the control rods	sintered boron carbide in a stainless can
(m) mean heat release	5000 MWD/tonne U
(n) period for refuelling	2 yr
(o) No. of cooling loop	2
(p) No. of heat exchangers per cooling loop	6
(q) total number of heat exchangers	12
(r) total number of primary circuit circulating pumps (including two spares). These are of the sealed type with submerged rotors	6
(s) rate of flow of each pump	1,322,400 lb/hr
(t) total flow of water through the reactor	5,289,600 lb/hr
2. Reactor vessel:	
(a) inside diameter	7 ft 6·5 in.
(b) inside height	16 ft 2·3 in.
(c) thickness	5·90 in.
(d) design pressure	1991 psi
3. Heat exchangers (designed for maximum power of 20,000 shp)	
(a) total number	12
(b) total steam output	255,664 lb/hr
(c) steam pressure	583 psig
(d) temperature of feed water	347° F
(e) pressure of the primary water circuit	1991 psi
(f) inlet temperature of primary water circuit	536·5° F
(g) outlet temperature of primary water circuit	502·0° F
(h) temperature rise of primary water circuit	34·5° F
(i) total quantity of primary water flow	5,289,600 lb/hr
(j) design pressure	853·2 psi
(k) material	austenitic steel (18/8)
(l) steam outlet (I/S dia)	2·95 in.
(m) primary water inlet and outlet	4·92 in.
(n) inside diameter of each heat exchanger	25·20 in.
(o) overall height of heat exchanger	18 ft 9½ in.
(p) type of tubes	U-shaped to enable use of a single water box, thus eliminating expansion difficulties
Containment vessel: Contains the reactor, the heat exchangers, the primary circuits with the pumps, valves and the tank, the pressurizing devices, purification and degassing.	
(a) diameter	29 ft 6 in.
(b) height	50 ft 10 in.
(c) maximum design pressure	384 psi
(d) material	steel with a yield point of 25·5 ton/sq in.
(e) stress of the material	21·2 ton/sq in.
(f) margin of safety on the yield point	20·0%
5. Main propulsion plant: Consists of H.P. and L.P. turbines, designed for ahead and astern, driving the single propeller through double reduction gearing at 100 rpm.	
(a) normal power	18,000 shp
(b) maximum power	20,000 shp
6. Auxiliary turbogenerators:	
(a) No. of sets	2
(b) rating of each set	160 kW

2.1. Assumptions

(a) Displacement 40,000 ton.

(b) Power:
normal 18,000 shp.
maximum 20,000 shp.

(c) Number of propellers, one.

(d) Route:
(1) Proposed longest run: From Marseilles to the Persian Gulf via the Cape.
(2) Marseilles to Syria.

(e) Tanker must operate both in port and at sea by nuclear power.

(f) For this prototype a stand-by power plant of 3000 hp is required for the supply of the auxiliaries.

(g) Types of reactors:
(1) Pressurized light water-moderated and cooled (Scheme A).
(2) Boiling light water (Scheme B).
(3) Graphite-moderated gas-cooled (Scheme C).

2.2. Pressurized light water-moderated and cooled reactor (scheme A)

A summary of the essential particular of the reactor, the reactor vessel, the heat exchangers, the containment vessel, the main propulsion plant and the auxiliary turbo-generators for scheme A is presented in Table IV. The nuclear plant consists of one reactor, using uranium oxide enriched to 1·5% and 12 heat exchangers. The weight of fissile material is 8 tonnes, which can last for two years. The reactor vessel has an inside diameter of 7 ft 6·5 in., an inside height of 16 ft 2·3 in. and a thickness of 5·9 in. It is designed for a pressure of 1991 psi. The inside diameter of each heat exchanger is 25·2 in. and the overall height is 18 ft 9½ in. The tubes are U-shaped which enables the use of a single water box, thus eliminating expansion difficulties. The containment vessel which houses the reactor, the heat exchangers, the primary circuit with the pumps, valves and the tank, the pressurizing devices, the purification and the degas-systems, has a diameter of 29 ft 6 in. and a height of 50 ft 10 in. and is designed for an internal pressure of 384 psi. The margin of safety on the yield point is only 20%.

The main propulsion plant consists of H.P. and L.P. turbines, designed for ahead and astern, driving through double reduction gearing a single propeller at 100 rpm. The two auxiliary turbo-generators have a rating of 160 kW each.

Table V.—NUCLEAR POWERED OIL TANKER

SCHEME B

BOILING LIGHT WATER-MODERATED AND COOLED REACTOR

1. Heat ratine of reactor	51·2 MW
2. Fissile material	UO_2 enriched to 0·0155
3. Weight of fissile material	7·988 tonne
4. No. of fuel assemblies	88
5. No. of fuel elements per assembly	8
6. Total number of fuel elements	704
7. Diameter of pellets	0·465 in.
8. Length of fuel rod	8·661 in.
9. Thickness of zircaloy jackets for pellets	0·039 in.
10. No. of control rods	21
11. Material for control rods	boron carbide
12. Canning material of the control rods	stainless steel
13. Volume ratio of water to UO_2	2·91
14. Water flow through reactor	5,289,600 lb/hr
15. Mean heat release	4000 MWD/tonne UO_2
16. Steam production	215,350 lb/hr
17. Steam pressure in reactor	796·3 psi
18. Steam pressure at inlet to main and auxiliary turbines	654·1 psi
19. Design pressure of containment vessel	136·5 psi

2.3. Boiling light water-moderated and cooled reactor (scheme B)

The principal design data of the reactor and the containment vessel is summarized in Table V. The heat rating of the reactor is 51·2 MW. The fissile material, which is UO_2 enriched to 0·0155, weighs 7·988 tonnes. There are 704 fuel elements, the diameter of the pellets is 0·465 in. and the length of the fuel rods 8·661 in. The steam pressure in the reactor is 796·3 psi and at the inlet to the main and auxiliary turbines 654·1 psi. The containment vessel, which is arranged horizontally, is designed for a pressure of 136·5 psi.

2.4. Graphite-moderated gas-cooled reactor (scheme C)

The significant details of the nuclear, the main propulsion and the auxiliary plants are presented in Table VI. This carbon dioxide cooled reactor has a heat rating of 60 MW. The fuel is uranium oxide with an enrichment of 1·8%, the total weight amounting to 6·5 tonnes. The pressure of the carbon dioxide coolant is 568·8 psi, which must be considered as exceptionally high when compared with 100 psi used for the 180 MW reactor at Calder Hall. The dimensions of the core are 11·5 ft dia and and 11·5 ft high. The total weight of the reactor is 102 tonnes. The reactor vessel, which is vertical and cylindrical with spherical ends, has a diameter of 16 ft 8 in., a height of 32 ft 6 in. and a thickness of 4·05 in. The containment vessel which encloses the reactor, the four heat exchangers and the auxiliaries of the primary circuit, has a diameter of 39 ft 4 in. and a length of 59 ft and is designed for a pressure of 71·1 psi. Each of the four heat exchangers has a diameter of 3 ft 7 in. and a height of 23 ft. There are four axial-flow single-stage gas circulators designed to run at 10,000 rpm. Each is driven by a steam turbine, supplied with live steam and exhausting at back pressure to the L.P. cylinder of the main propulsion turbine. A starting motor has been incorporated, which normally cuts out at 1000 rpm. It is rated at 2·5 kW. The main propulsion unit consists of H.P. and L.P. turbines, the latter having both the forward and the astern blading and double reduction gearing. There are two steam turbine driven auxiliary generators, each at 1200 kW. In addition there is an auxiliary propulsion turbine having a condenser and also astern blading. It is rated at 3000 hp ,and drives the propeller through a pinion meshing with the first reduction gear of the double reduction gearing. The auxiliary plant includes also two condensing turbines of 800 kW each and two auxiliary boilers, producing steam at 48,490 lb/hr (max.) and 256 psi. One of these is kept constantly under pressure by a small auxiliary boiler of 4408 lb/hr capacity.

Table VI.—NUCLEAR POWERED OIL TANKER
SCHEME C
GRAPHITE-MODERATED GAS-COOLED REACTOR

1. Reactor:	
(a) No.	1
(b) heat rating	60 MW
(c) fissile material: uranium oxide (UO_2)	
(d) enrichment	1·8%
(e) cooling gas	CO_2
(f) weight of fissile material	6·5 tonne
(g) No. of fuel assembly channels	223
(h) diameter of fuel assembly channel	3·346 in.
(i) length of fuel element	68·9 in.
(j) No. of fuel element per assembly	19
(k) total number of fuel elements	4237
(l) diameter of fuel element tube, containing sintered uranium oxide pellets	0·315 in.
(m) thickness of fuel element tube	0·008 in.
(n) maximum temperature of fuel element	1112° F
(o) pressure of cooling gas (CO_2)	568·8 psi
(p) velocity of cooling gas	98·4 ft/sec
(q) gas temperature at outlet from reactor	932·0° F
(r) thickness of graphite jacket surrounding fuel tubes	0·276 in.
(s) No. of control rods	24
(t) diameter of core	11·5 ft
(u) height of core	11·5 ft
(v) thickness of the reflector surrounding core	16·9 in.
(w) total weight of reactor	102 tonne
(x) maximum total CO_2 flow in reactor	200 tonne
2. Reactor vessel:	
(a) vertical, cylindrical with spherical ends	
(b) diameter	16 ft 8 in.
(c) height	32 ft 6 in.
(d) thickness	4·05 in.
3. Containment vessel:	
(a) diameter	39 ft 4 in.
(b) length	59 ft 0 in.
(c) design pressure	71·1 psi
4. Heat exchangers:	
(a) No. of heat exchangers	4
(b) diameter	3 ft 7 in.
(c) height	23 ft
(d) temperature of gas at inlet	932° F
(e) temperature of gas at outlet	536° F
(f) gas temperature drop	396° F
5. Circulators:	
(a) No.	4
(b) type	axial flow, single stage
(c) normal speed	10,000 rpm
(d) drive: steam turbine, supplied with live steam and exhausting at back pressure to L.P. cylinder of main propulsion turbine	
(e) starting motor (which normally cuts out at 1000 rpm) rating of motor	2·5 kW
6. Main propulsion unit:	
(a) H.P. and L.P. turbines. (The latter with both forward and astern blading)	
(b) L.P. cylinder also receives exhaust from turbines driving axial flow circulators	
(c) double reduction gearing	
7. Steam turbine driven auxiliary generators:	
(a) No. of sets (including one standby)	2
(b) rating of each set	1200 kW
(c) total rating of both sets	2400 kW

Table VII.—COMPARISON OF THE REACTOR SCHEMES A, B AND C

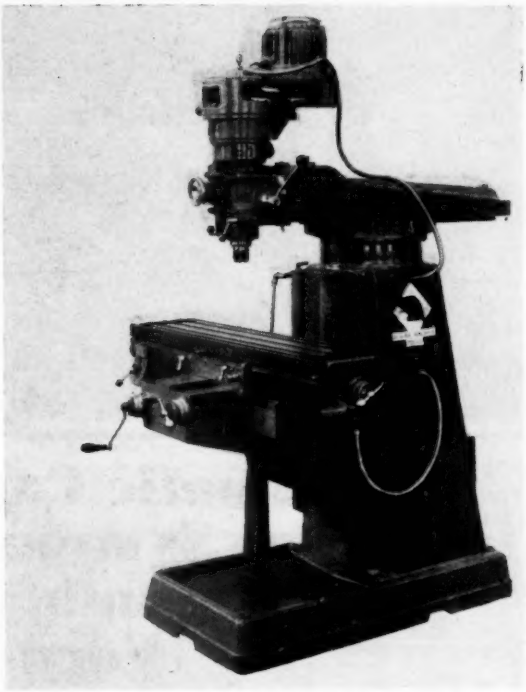
Scheme A: Pressurized light water-moderated and cooled.
Scheme B: Boiling light water-moderated and cooled.
Scheme C: Graphite-moderated gas-cooled.

	A	B	C	Unit
1. No. of reactors	1	1	1	
2. Enrichment of uranium oxide	1·5	1·55	1·8	%
3. Weight of fissile material	8·0	7·988	6·5	tonne
4. Diameter of the uranium oxide pellets or fuel rods	0·3937	0·465	0·315	in.
5. Length of fuel rods	59·05	8·661	68·9	in.
6. Mean heat release	5000	4000		MDW/tonne UO
7. Core: diameter			11·5	ft
height			11·5	ft
8. Pressure vessel:				
inside diameter	7 ft 6·5 in.		16 ft 8 in.	ft in.
inside height	16 ft 2·3 in.		32 ft 6 in.	ft in.
thickness	5·9		4·05	in.
design pressure	1991			psi
9. Heat exchanger:				
number	12		4	
inside diameter	2 ft 1·2 in.		3 ft 7 in.	ft in.
height	18 ft 9·5 in.		23 ft 0 in.	ft in.
10. Containment vessel:				
diameter	29 ft 6 in.		39 ft 4 in.	ft in.
height	50 ft 10 in.		59 ft 0 in.	ft in.
design pressure	384	136·5	71·1	psi
11. Main propulsion plant:				
H.P. and L.P. turbines	Yes		Yes	
double reduction gearing	Yes		Yes	
speed of propeller	100			rpm
steam pressure at inlet to main turbine	583	654·1		psi

2.5. Comparison of the three reactor schemes

Unfortunately it has not been possible to make a true comparison of the most essential design data for in certain instances information is not available. This applies particularly to scheme B as indicated in Table V. Moreover, it is not possible to assess the merits for this design study because of the absence of relative costs and details of weights with the space occupied. A closer examination of the dimensions of the pressure vessel and particularly the containment vessel (items 8 and 10 in Table VII) reveals that the pressurized light water-moderated and cooled reactor occupies considerably less space, which is an advantage.

[The author will deal with Japanese development in the next issue.]



The new Beaver VBA (left) light and VBRP (right) medium duty milling machines have universal movement to the head and separately driven table feed.

New Beaver Milling Machines

Two new Beaver vertical precision milling machines, one for light work and the other for medium duty, have been developed by Balding Engineering Limited, Beaver works, Bessemer Road, Norwich, basically from a scaling up of their successful Model A machine. With the exception of the headstocks the two new machines are similar, having the same table dimensions of 10 in. wide by 32 in. to 48 in. in four sizes, the same independently motor driven table feed, and the same cross traverse of 12 in. and vertical traverse of 19 in.

In the light machine, the Beaver-VBA, the head is in the form of a swivelling turret with $\frac{3}{4}$ hp motor at the back driving the spindle at the front by primary and secondary V-belts and 5-step pulleys. The belt tension is readily adjusted at the idler by a quick-acting lever-operated cam. The pulleys are mounted on precision ball and taper roller bearings with the aid of splined drives so that belt tension does not come on the spindles. The tool spindle is in an accurately machined quill, hard chrome-plated on the outside and embodying a machine-cut rack. There is a rapid traverse for plunge cutting a radius with a milling cutter or for drilling, reaming etc., with instant change to fine feed for fine boring etc. The quill is spring loaded for automatic return. A depth micrometer reading to 0·001 in. and rule movement of 3 in. are provided. The whole of the headgear is rotatable and also swivels and slides on the cylindrical member.

The Beaver-VBRP medium duty machine has an all-angle milling head in one unit and is provided with eight speeds, selected by quick action lever. Drive is by V-belt from the balanced motor to a four-step pulley and thence through precision cut helical back gearing to the splined driving sleeve. The same principle in spindle mounting is used, so again the spindles are freed from all load except the working torque. Matched, pre-loaded bearings are used and the quill, again, is hard chrome-plated. All rotating parts are balanced. The spindle travel is 5 in. and a single handlever and micrometer collar gives rapid movement while fine feed is from handwheel and worm and wheel. The quill has three rates of power down feed per spindle speed and is self-retracting.

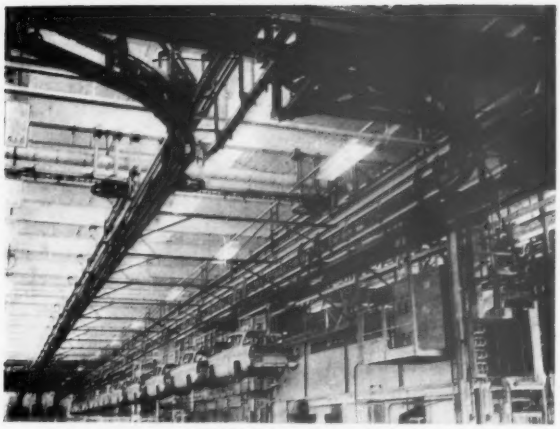
The ram of the prismatic overarm is actuated by rack and pinion and revolves with the turret; there is also 45° inwards and outwards rotation of the head.

The gearbox for both machines is a neat arrangement. It can be supplied in two ranges of feed, $\frac{1}{2}$ in.—$4\frac{1}{2}$ in. or 1 in.—9 in. per min. The pick-off gears are driven by worm and wheel from an independent 0·1 hp motor.

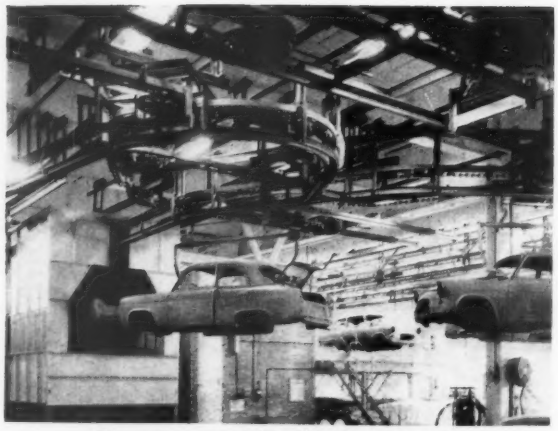
Traction Batteries Give 35% More Power

The new Exide-Ironclad battery with "gauntlet" plate construction manufactured by Chloride Batteries Limited, Exide Works, Clifton Junction, Swinton, Manchester retains the benefits of the tubular construction of the positive plates and takes full advantage of the great strides which have been made in the development of plastics in recent years. The result is a battery which gives up to 35% more power in the same space, for about the same weight.

The outstanding feature is the multi-tubular "gauntlet" of resin-impregnated Terylene cloth which is slipped over the spines of CB. 95 alloy of the positive plate and holds the active material in a grip that is not only firm but elastic. Terylene in addition to being resistant to sulphuric acid and oxidation, combines tensile strength with elasticity, thus it is able to accept the extensive forces that develop during each operational cycle of the battery without risk of fatigue or failure, and yet it is so resilient that it returns to its normal state throughout its life.



Bodies in line storage at the beginning of the process in the paint shop



The conveyor turns and the bodies enter the slipper-dip

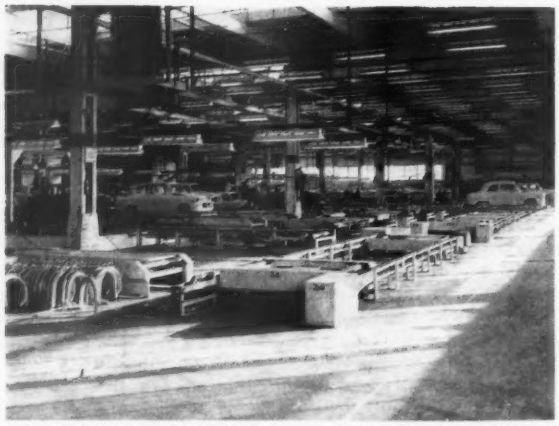
Automatic Car Body Handling Conveyor System in New Paint, Trim and Assembly Building of the Ford Factory

THE new paint, trim and assembly building of the Ford Motor Company Limited, Dagenham, cost £10 million and was the last and largest phase of an expansion programme started in 1954. It is two storeys high, 1,215 ft long and 630 ft wide, with a number of subsidiary buildings and plant houses. The paint shop is on the first floor and the trim and assembly shop on the ground floor.

The design of the building and the siting of the process plants were largely determined by the system of conveying the bodies through the shop. The design and installation of the complete mechanical handling system was undertaken by Geo. W. King Limited, who worked in close co-operation with Ford planning and production engineers. This conveyor installation is entirely automatic and comprises overhead and floor conveyors incorporating a system of "indexers" which call bodies from one section to another, with automatic transfer sections for movement from one system to another, including the passing of the painted bodies into the trim and assembly shop on the ground floor below. Approximately ten miles in length it may at any time be carrying over 1,500 bodies.

The bodies are loaded on the King "Dual-Duty" overhead conveyor by pushbutton-operated drop sections at the pick-up points in the "body-in-white" shop. The drop sections are an essential part of the system and occur throughout where it is necessary to transfer from floor to overhead or overhead to floor conveyor.

When the drop section is raised, the body, which is attached by steel slings, is automatically moved forward into a six-bank indexer section from where it is subsequently called into the main transport conveyor. The indexer is a device for stopping and starting a load trolley without stopping the conveyor itself, and is employed for storing bodies on live-line track until they are required. Should the main transport conveyor stop due to a hold up in the paint shop, the body remains

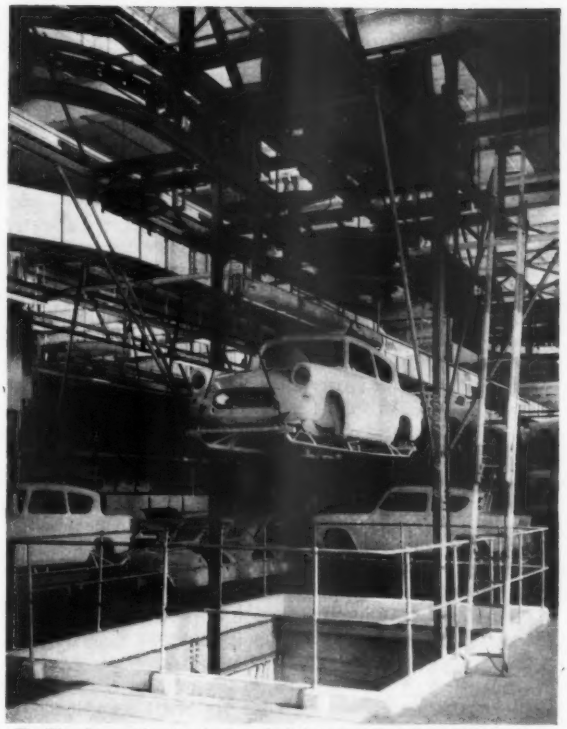


At the end of the painting lines the bodies are passed across the end of the shop direct to storage or transferred to the two-tone plants

in this indexer section, while an interlocking device prevents the drop section from operating after the last indexer has been filled.

The processing plants throughout the paint shop are duplicated, and as the bodies arrive over the conveyor bridge they are automatically transferred to two lines in alternate rotation, where they are first held in storage. Should any variation in production cause a stoppage to one line, and the subsequent filling of the storage section, bodies will automatically pass to the line able to receive them. When that line is filled the main transport conveyor stops. Re-starting is automatic when the last indexer in either line becomes vacant. Electric switches are also provided adjacent to the transfer points should it be desired to isolate one line.

Bodies are released for entry into the first of the process plants, a six stage phosphating machine, by an empty pusher dog on the return strand of the conveyor



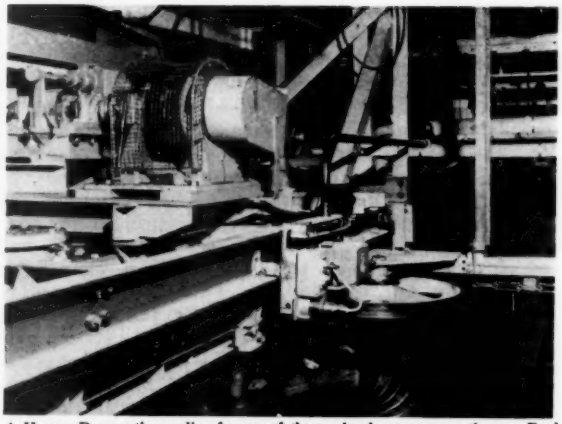
The King drop section transferring a body into the trim and assembly shop below

The King twin strand conveyors are ramped down in the trim shop where aisles have to be crossed

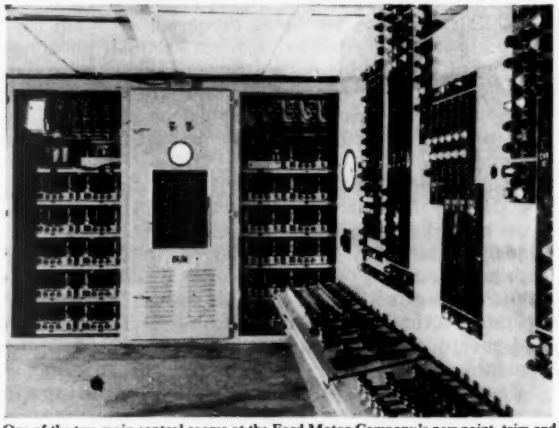
feeding this plant. Leaving the phosphating machine the bodies are passed into the dry-off oven. Here a special feature of the Dual-Duty conveyor allows the automatic stripping of bodies from the ovens to overhead storage lines without losing sequence of flow at such times as meal breaks, end of shifts etc. In addition, the length of chain subject to corrosion and wear is confined to the phosphate machine only.

After travelling through the upper sealer deck, the bodies, having reached the end of the shop, are turned and continuing in two lines of duplicate processing, receive underbody treatment in the "slipper dip" where the Dual-Duty is sufficiently dipped down above the tanks.

After primer spray booth, primer bake oven and cooler, the bodies move forward to a drop section for



A Heenan-Dynamatic coupling for one of the overhead conveyors at the new Ford paint, trim and assembly building, Dagenham



One of the two main control rooms at the Ford Motor Company's new paint, trim and assembly building showing (right) the master control panel and (rear) Heenan-Dynamatic Coupling excitation units and speed trimming potentiometers

changeover from overhead to floor conveyor. During this changeover, skids are fitted to the underside of the bodies and the slings released when the bodies have been positioned on the floor conveyors. The slings remain attached to the drop section which is then raised by pushbutton control, and before being returned by overhead conveyor to the body-in-white-shop for recommencement of the cycle, are passed through a wash for the removal of paint overspray.

The King floor conveyor comprises a two strand roller chain forming a moving line on which the bodies rest on their skids. This conveys them through the primer wet sand deck and dry-off ovens, and on to a further section placed at right angles for transfer to the next down-shop process. In order to keep the bodies in "road" position, turntables have been included in the last section of the line so that they are in the correct position on the powered rise and transfer table.

The powered transfer table, which occurs at various points where transfer at the same level is required, is entirely automatic in operation, the movement of the tables being controlled by limit switches operated by the body skids. The body travels forward on one conveyor and at a pre-determined position a limit switch is operated which lifts the table in the transfer conveyor, to which the body is then passed. Once the body is in position, the table lowers, depositing the body on the transverse moving chain. A further table lifts the body

clear of the transverse chain and propels it to the receiving conveyor at the tail end.

The bodies now receive their ground coat sprays; are passed through wet sanding and baking process and finally receive their enamel spray. After they have travelled through the final baking oven, they may be passed directly to storage lines to await transfer to the trimming shops or, in the case of two-tone colours, may be transferred to the two-tone plants before joining the single tone bodies.

Each paint booth and oven has its own system, into which bodies can be stripped during a close-down period to prevent "oven bake" and discolouration, and to enable the plant to be cleaned out. These stripping lines consist of a series of gravity idlers carried between twin strand chain in conjunction with transfer conveyors at right angles. Once selected by pushbutton, the stripping operation is completely automatic; on restarting, the bodies are fed back into the main production flow to match up with those already in the system.

While the bodies are being prepared, all small parts are being separately treated through a similar phosphate and paint system by King "Power-Pulled" conveyor. This system is a continuous flow through primary spray booth, two-pass oven, enamel booth, and three-pass oven. Completed parts are delivered to the trim floor by lift.

The completed bodies wait in storage lines ready for transfer to the trim shops below through three body drop points, automatically sequenced according to the models. Here they are transferred to "Dual-Duty" overhead conveyor employing, once again, the system of drop sections. The bodies are lowered on power operated turntables where operators release the slings and return them to the paint shop by push button control.

On reaching a pre-determined point on its upward movement, the empty sling carrier operates a limit switch to rotate the turntable through 90° to bring the body in line with the trim conveyor. As the body is passed off the turntable a further limit switch is operated which returns the table to its original position to receive the next body.

The trim shop comprises three separate conveyor systems. All trimming operations are carried out on King two-strand conveyors, the bodies being transferred from one line to the next by cross transfer conveyors and power operated lift tables. Where aisles have to be crossed the transfer conveyor is ramped down to floor level and up again to the next conveyor at operational height. This enables trim stock to be delivered direct to the line by fork lift trucks.

The trimmed body is selected for water test, repair line or into final storage bank ready for delivery to the final assembly lines. Delivery to these lines is by closed hoist systems on which a number of hoists are carried. These are automatically held in waiting stations to be called for by the passage of the preceding body. Hoist systems and assembly lines are electrically interlocked to ensure that a station is vacant before a body is brought into position. An operator releases the body slings and raises the hoist which is then taken over by automatic sequencing. When the body is raised, the skids are removed and passed back into the paint shop, through a washer and unloaded for storage by an overhead Power Pulled conveyor. Sub-assemblies, wheels, tyres and seats, which have been prepared on slat conveyors at bench height elsewhere in the building, are delivered to the appropriate position by floor and overhead conveyors.

In order that the scheduled body is matched up, the delivery of sub-assemblies is carefully regulated under a control system incorporating a teleprinter service which ensures that the right component is brought to the right body at the right time, and throughout both the paint and trim shops early warning stations are located to amend the overall schedule when certain bodies have been allocated for repair; late warning stations are located at the storage banks prior to the body being hoisted to the final line where last minute adjustments to schedules are made. Such warnings are sent to all points so that similar adjustments can be made to seats, wheels and sub-assemblies.

At the end of the final assembly line the engine is started and the car driven to toe-in pits and roll test. For final preparations the bodies are carried on floor slat or drag conveyors and through the garage where they are stored ready for despatch.

All conveyor operations are chanelled through main control rooms built on the floors of the paint shop and trim shop. This includes a control desk over which a "Master Mimic" indication diagram is installed with indication lamps to show conveyor movement. For every conveyor a variable speed potentiometer is provided for the adjustment of speeds to suit production requirements, in relation to neighbouring conveyors.

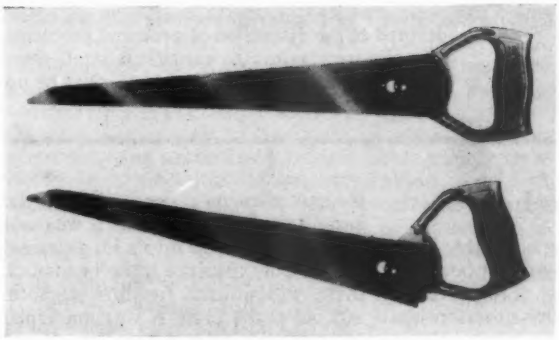
Every conceivable change to conveyor movement, or interruption to the flow of bodies, is immediately seen on this chart, so that the apparent complexity of the system is simplified through this "nerve centre".

All the variable speed couplings and related electronic control gear for the conveyors at the plant were supplied by Heenan & Froude Limited of Worcester. The couplings—air cooled Heenan-Dynamatic controlled slip models—have been installed in five different sizes to suit the varying power requirements involved. The bulk are under group control from the main control rooms, one on each of the two floors, the remainder being operated from local control panels sited throughout the plant. A feature of the lay-out is that the speed of each conveyor in any one group may be individually trimmed by means of potentiometers located on separate panels in the main control rooms while the entire group remains under the master control of the main control panel.

Several of the larger conveyors utilize more than a single drive unit. In such cases one coupling is used to control the overall speed of the conveyor, the others to share the load and to limit the chain pull on the conveyor to an acceptable maximum.

In a plant such as this, where it is frequently necessary to transfer a motor body from one conveyor to another at various stages of assembly, a very high degree of synchronization is required. To meet this the well-tried Heenan & Froude method of positively synchronizing a number of drives at a transfer junction has been employed. This involves the use of differential voltage signals derived from Magslips, one Magslip being positively driven from each conveyor.

The general design of the Heenan-Dynamatic coupling is notable for its simplicity. Relatively few items are involved in its construction and of these the only wearing parts consist of the ball bearings and slip ring brushes. In consequence it is able to provide trouble-free service almost indefinitely—an essential quality in a plant of this type where even a minor breakdown could appreciably affect production throughout the shop.



"Eclipse" No. 66 General purpose saw

A Saw to Cut Anything

A disadvantage of most saws is that they are designed to cut certain materials only. Metal cannot be cut with a joiners' saw nor wood satisfactorily with a hacksaw. And when a combination of wood and metal has to be cut, for example, floor boards in which nails are embedded, a real problem arises. A saw which has been needed for years is one that will cut, easily and quickly, both wood and metal (and other materials), and it has now appeared in the "Eclipse" No. 66 general purpose saw (Regd. Design Nos. 890827 and 891263). It has a 16 in. tungsten steel blade which is specially tapered to facilitate sawing in confined spaces and which can be quickly positioned and locked at any one of nine different angles relative to the handle, a feature which makes the saw ideal for cutting materials in awkward positions. The blade clamping screw and wing nut cannot be separated and, therefore, cannot be misplaced or lost.

The saw will cut easily such materials as hard and soft wood, wood in which nails or bolts are embedded, hard rubber, plastics, fibreboard, and small tubes and bars made from mild steel, copper, brass, aluminium, lead and the like. The blade is extremely hard wearing but when it does have to be replaced a new blade can be fitted in a few seconds.

This new saw is not intended as a substitute for the specialized saws but as the one saw in the kit which will act in almost any position and will do the odd sawing job irrespective of whether the material is metal, wood, plastic, etc. It is on these occasions that the usefulness of the Eclipse general purpose saw will be most obvious and its value most appreciated.

The retail price is 15/6d., and spare blades 6/6d. each. The manufacturers are Jas. Neill & Co. (Sheffield) Limited, Napier Street, Sheffield 11.

Ohmmeter and Flash Tester

A new ohmmeter in the Nashton range of miniaturized electronic test equipment will measure resistances between 10 ohms and 10,000 ohms in eight ranges to an accuracy of $\pm 3\%$. The ohms ranges each cover two decades and the megohm ranges one decade, although they are switched in one decade steps. This enables the resistance value to be read in the centre portion of the scale where the accuracy is greatest. A Weston moving coil meter with a knife edge pointer and a mirror scale are incorporated. The ohmmeter uses a balanced bridge circuit of two double triode valves fed from a stabilized H.T. line. The voltage fed to the bridge from a potential divider is proportional to the unknown resistance which forms a section of the potential divider. The instrument measures $8\frac{1}{2}$ in. $\times$ 5 in. $\times$ 5 in. overall and is designed for operation from 205 to 245 V, 40/60 c/s mains with a consumption of 16 VA. The price is £52. 10s. 0d.

A further addition to the same range is a flash tester which provides a 50 c/s a.c. test voltage variable from 500 to 2000 V in sixteen 100 volt steps. The instrument is designed for insulation testing to B.S. 816:1952. The test voltage is derived from the high voltage secondary of a transformer via a current limiting circuit, and is varied by a 16-step plus OFF rotary switch connected to the primary winding of the transformer.

The applied voltage and the associated leakage current are indicated on a $4\frac{1}{2}$ in. rectangular, 1 mA, moving coil meter, the appropriate meter scale being selected by a two-position switch. The probe tip is shielded by a spring loaded insulating sleeve which is retracted when required for use. The maximum short circuit current is 4 mA which is below the hold-on value.

The instrument operates on a 200 to 250 V a.c. 40/60 c/s mains supply with a consumption of 4 VA. The overall dimensions are $8\frac{1}{2}$ in. $\times$ 6 in. $\times$ 6 in. and the price is £26. Both instruments are made by Nash & Thompson Limited, Chessington, Surrey.

Heating/Quenching Furnace

A new vacuum furnace in which the charge can be heated and quenched without exposure to the atmosphere is being used for the heat-treatment of such metals as molybdenum, titanium and tungsten, stainless steels, and high-temperature alloys, including nimonic.

The furnace is resistance-heated by a molybdenum winding, which can raise the temperature of the hot zone to a maximum of 1500°C. Insulation is by means of radiation shields, and the furnace chamber is water-cooled. Below the furnace chamber is a trap-door, leading, via a sealed hood, to the quenching-tank. There is an atmosphere of inert gas (argon) in the hood at about atmospheric pressure.

The hot-zone is 24 in. dia, and 24 in. high, and the charge is hung in a basket from the lid. The air is then exhausted from the chamber with a 10 in. oil diffusion pump (whose capacity is 2,500 l/sec at 10^{-4}mm Hg), backed by a standard mechanical pump. The temperature of the hot-zone is then raised and controlled as required, and when the charge is ready for quenching, argon is admitted to the furnace chamber. When the pressure inside equals that in the sealed hood below, the bottom trap falls open, and the charge-basket is automatically released and falls into the quenching-tank. The release and quench operation takes about 5 sec. The whole cycle takes from 20–60 min, according to the thermal capacity of the charge, and the temperature to which it is raised.

The furnace is made by Vacuum Metallurgical Developments Limited, Shelford, Cambridge.

Lightweight Blowpipe

A new welding blowpipe, the "Lightweight Saffire", has been added to the range produced by British Oxygen Gases Limited, London. It is specially for welding sheet metal and light repairs and weighs only $9\frac{1}{2}$ oz. It has a new type mixer to provide a stable flame.

technique

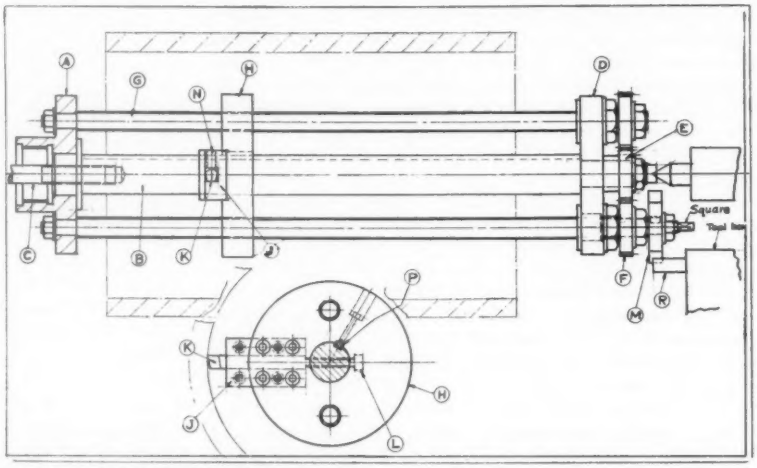
—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Boring a Large Cylinder on a Lathe

Operations which in the larger type of engineering workshop are considered of an elementary nature can, however, present to the small factory awkward and often insurmountable problems, or they may demand the construction of special equipment before a satisfactory conclusion is attained; and much of this latter work is usually an adaptation of existing machine tools or tooling with a view to increasing the capacity of the particular machine to enable it to undertake a task which in normal circumstances initially appears impossible. An old and frequently neglected machine destined for the scrap heap because it has long passed its apparent useful period of life, is sometimes overhauled and used as a special purpose machine for some particular operation when the quantity of parts justifies the cost of such work, and as the centre lathe is an ideal tool for so many different operations, consideration is always essential before disposing of a seemingly worn out machine.

A typical instance where an old lathe gave further service occurred when it became necessary in a small workshop to bore out a series of thick wall tubular castings having an outside diameter of about 8½ in., a length of 15 in. and a bore size of 7 in. ± 0·002, which had previously been machined by a larger firm to the requisite dimensions. A drawing alteration necessitated a further skim through the bore removing some 0·03 in., an operation which at first gives the impression of taking but half an hour to perform and without any special set or tooling equipment. However, boring a long hole of this size requires a heavy lathe having a rather long bed which the shop in question did not possess, and a simple set up was thus needed using, if possible, an old lathe which did service as the jack-of-all-trades machine on which the great majority of simple polishing processes were carried out.

Boring from the tailstock was soon discounted because the long overhang of a boring bar meant that chattering would undoubtedly occur, and the question of providing a suitable feeding arrangement for a component of this length presented a rather difficult problem. A similar situation was noted with relation to a bar held in the traditional manner in the tool post; in fact used in the way the machine was originally intended gave the impression that the job was far too massive for the construction of the lathe.



Care is essential in boring the centre distances of the screws to see that they are exactly alike as any discrepancy between them will cause stickiness in the action of the sliding member. A cover over the gears is advisable if a considerable amount of swarf is removed from the bore

However, by converting the machine into a horizontal boring machine where a massive bar supported at each end passes through the component, the operation was feasible if it were possible to provide the tool with the necessary feed without the mechanism costing too much. How this was accomplished is shown in the sketch.

Holding the cylinder did not present any difficulty and a simple veeblock style of holding device with a substantial wrap round clamp was sufficient as a lateral location was unnecessary; the only important feature of this fixture being the dimension from the machine bed to the rotation centre line, and this was easily achieved by careful planing of the base surface.

The fact that the tool bar rotated instead of being stationary imparted a motion to the bar which was not difficult to change into a longitudinal movement; thus the lathe headstock drive was utilized for this purpose. An old catch plate A was machined to receive a central bar B, and the latter, as the sketch illustrates, was flanged and held tightly against the surface of the catch plate by the draw bolt C that passed through the headstock spindle. This bar was reduced at the remote end to accommodate another plate and an idler gear E while the end ultimately provided a bearing for the tailstock centre.

Both the plate D and the catch plate A were bored to receive shouldered screws—the centre distances between these long screws G was unimportant, provided they were both exactly the same dimension, as the sliding plate H had to move back and forth without any suggestion of stickiness that could cause jamming and so set up severe wear between the parts. Again, both these screws located gears that meshed with the central idler gear and the slight error that might occur in the centres as mentioned above did not seriously affect the working of this device because the drive was always in one direction. Finally, one screw had a star wheel outside the gear and all gears, together with this latter wheel, were nutted to their respective shafts.

The sliding plate was grooved to receive the tool box—a simple affair

consisting of a grooved member J in which a single point tool K was fitted and held down by means of socket screws. As the cutting pressure imparted by this operation was very light, this was enough to clamp the tool securely and a set screw L behind the cutting member was sufficient to give a slight movement when necessary for final setting following grinding.

The operation of this boring head is as follows. Assuming the cylinder has been clamped in position and the tool is at the tailstock end with the centre in position, the machine is set in motion. At each revolution the star wheel contacts the bar set in the lathe tool box or perhaps if it has been found convenient to remove the saddle, an angle plate secured to the bed provides the same type of obstruction for the rotating wheel, and on striking such a projection it moves a portion of a revolution. This naturally causes the gear M to turn a like amount and the same degree of motion is imparted to the two long screws. As the sliding plate cannot move in any other direction other than a lateral one, this movement causes that part to slide toward the headstock a small amount. Continued striking of the star wheel at each revolution produces the necessary feed to the tool—the distance being equal to the feed, until the tool has progressed completely through the cylinder.

This feed is easily calculated because the two screws are cut 20 tpi which gives an 0·05 in. pitch and as the star wheel is milled to give 16 serrations, it follows that on striking the projection a movement of $\frac{1}{16}$ of the pitch is given to the tool. Thus 0·062 × 0·05 gives a feed of 0·0031 in. per revolution of the boring bar, and as a rotation speed of about 125 rpm was employed, this meant that for a distance of 15 in. which requires 5000 revolutions to complete, a time of 40 min was necessary for the cutting process. Added to this an approach and run-off time, plus loading and unloading, the time taken for the complete machining operation was in the region of 50 min.

A device of this design is not confined to a lathe though undoubtedly it operates successfully on this machine tool because of the easy loading facilities and the usual position of the tailstock centre, but there is apparently no reason why the enlargement of large holes using this form of construction is not feasible on either a drilling or horizontal milling machine. In the case of the drilling machine, one of the radial type is the obvious choice and the only real difficulty is the guarding of the gears from swarf dropping from above, but in the case of a milling machine almost the same conditions as applied to a lathe are present, and the provision of an outboard centre to give the necessary support to the gear end is not difficult.

Other than perhaps casehardening the star wheel, as this meets with continued tapping over a long period that naturally causes the serrations to be damaged in time, there is no need to treat the other parts in any way, but some attention to the machine bearings is essential to avoid chatter. Finally, the return of the tool to the tailstock end is an awkward problem unless some assistance outside the fixture is employed because there is no way of releasing the sliding member from the screws and so allow it to retract quickly. If the machine spindle is reversed and speeded up a faster return is obviously obtained and this may suit, but the introduction of an electric drill to the squared end of the star wheel shaft can turn it fast enough to bring the sliding plate back to the tailstock end in a matter of seconds. A simple "chuck" is made for this purpose by turning a piece of steel to fit the drill chuck and then milling a slot across the end to fit over the square on the shaft.

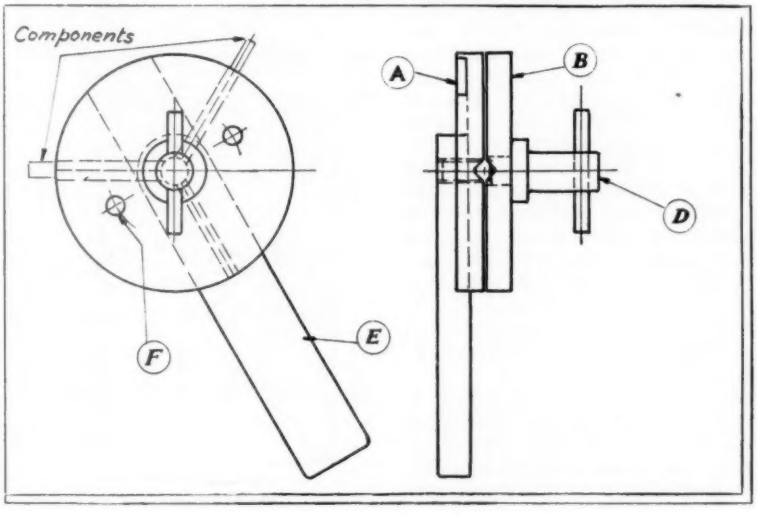
Special Jaws for Holding Small Circular Components

For dressing or filing a flat on small circular components, the usual bench vice can be awkward unless lead jaws are used in which the parts tend to bed themselves. A special set of holding jaws is both economical and helps towards better work, and it comes in useful for holding circular parts while cross holes are drilled in the ends as the handle shown in the sketch makes it easy to grip with the hand.

Two discs about 4 in. dia and cut from a length of bright mild steel are suitable for parts A and B but they differ slightly as one is a fixed jaw while the outer one is used for clamping. Drilling and tapping are provided for the screw D and a long groove is milled in the rear face to fit over the bar E. The clamp plate is drilled and bored to pass over the shank portion of the screw but has matching V-grooves with the locating plate. Both parts are also provided with pins F which align them correctly.

Any number of vees are machined in the plates but three will generally cover a fair number of different components. Access to the groove running parallel to the shank is obtained by rotating the plates through 180°. The shank is a piece of mild steel bar—a length of $\frac{5}{8}$ in. × $1\frac{1}{4}$ in. section is ideal, and one end is rounded to give a reasonable finish.

If diameters are considered preferable to using vees as a holding medium, then soldering the plates together for drilling and reaming provides a much better hold than simply clamping them together.



Clamped in the bench or machine vice this fixture gives conveniently spaced sockets for holding small components

Short-stroke Core-withdrawal Mechanisms

Toggle locks, as used to hold diecasting machines tightly closed under high injection pressures, are also an effective means of locking core blocks in casting position. In the forms generally adopted, however, they are clumsy, heavy, and useful only with very short strokes. Recently, a novel utilization of the toggle principle has appeared in a light and compact "toggle ram" actuated by pneumatic or hydraulic means. This provides a positive lock and exerts an initial pull of thirty tons for a line pressure of 1000 psi. Because the unit is demountable and can be changed from one die to another, construction costs are reduced

By H. K. BARTON

THE most widely adopted method of operating sliding cores is the finger-cam, and in particular the straight finger of cylindrical section usually termed an "angle-pin" (Fig. 1). Mechanically, this is undoubtedly the simplest possible way of reciprocating a slidable die element in a plane, normal, or nearly normal, to the axis of die movement. Some of the disabilities of this type of movement in the case of cores having a long withdrawal stroke have already been discussed (MECHANICAL WORLD, May, 1959), and it is proposed to consider here the possibility of using—with advantage—alternative methods in the case of relatively short strokes.

This is a point which often goes by default since there is usually no operational objection to providing a core with a stroke much longer than is actually required to bring it clear of the casting. Often, therefore, a core which requires only $\frac{1}{8}$ in. travel is lifted half an inch or so. There is little objection to this if the core is of small size and not likely to encounter large axial thrusts, but short-stroke cores of large area must be provided with heavy locking wedges to withstand the pressure generated during injection. These safety measures add appreciably to the cost of the tool, and however short the stroke, constructional costs are substantially unaltered. There is, accordingly, a good case for adopting simpler core-pulling methods when the stroke is so short that angle-pins are not essential, and especially so when the face of the core forms part of the cavity in the moving die member.

In such cases it may suffice to provide a relatively light core-block slidably mounted in the side of the cavity insert, and actuated by a pin, or a pair of pins, passing through the rear of the moving member to contact the ejector-plate. A core-withdrawal of this type is illustrated in Fig. 2, and it may seem that little less work is involved in its construction than in a conventional sliding block and angle-pin movement. In point of fact, the adoption of the method illustrated greatly reduces the size and weight of the moving block, and—in the particular example shown—permitted a slight reduction in the size of the main die-block. This is attributable to the fact that the face area of a sliding block is determined by the area of the casting surface which it forms, the remaining dimensions are chosen to give an adequate engagement with the keyways or other guiding surfaces. As a result, the front face of a conventional core-block is almost invariably larger than the face it presents to the cavity.

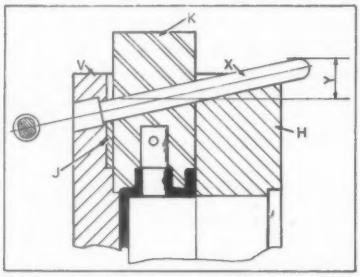
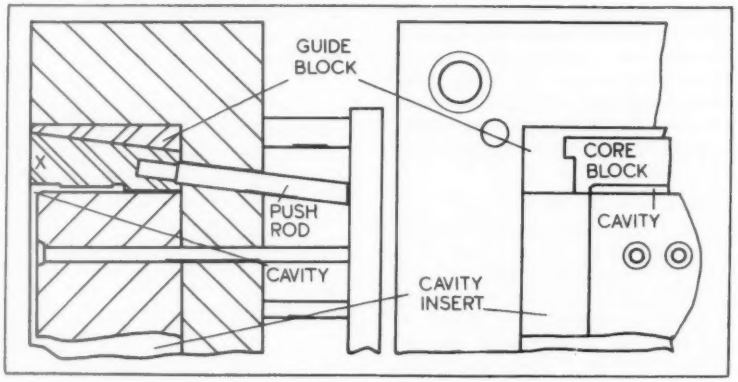


Fig. 1.—Typical finger-cam core withdrawal, in which block K rides up the angle-pin X to withdraw the core through a distance X

Fig. 2 (below).—Operation of a core-block by means of a push-rod which is in contact with the ejector-plate

This proportionality does not hold when the core is housed in the solid die-block and slides forward instead of moving laterally, as in Fig. 2. Moreover, there is no possibility with this method of the core being displaced under pressure, which renders it particularly suited to tools where the side core forms a large area of the casting surface and would, with any other type of construction, require heavy-duty locking wedges to prevent movement. As will be evident from the figure, the forward movement of the core-block is equivalent to the stroke of the ejectors, and the required obliquity of the guiding pins seldom need be more than five degrees. The additional thrust needed to advance the ejector-plate is thus not great. With most dies of this sort, the ejector stroke is likely to be sufficient to bring the block clear of the die face, and indeed it is desirable to proportion the tool so that this always occurs. This allows the free use of an



air-blast to clear debris from the housing.

The return of the block is effected automatically at die closure, but it is important to remember that the face X slides laterally across the face of the fixed member during closure. Neither face, therefore, must bear any features which could impede this movement. It is necessary to bear in mind also that the block in its advanced position must not prevent the diecasting from being easily removed from the die; because of this, blocks should normally be located either above or on the off-side of the cavity. Unless the machine in use has an abnormally long opening stroke, it is not desirable to fit a pair of opposed blocks of this sort, for there is little clearance between them. Only if the casting can be drawn forward clear of the blocks before being moved sideways out of the die can such a tool be operated; on the whole, where opposed faces of a large component require core-pulls it is better to adopt a different movement.

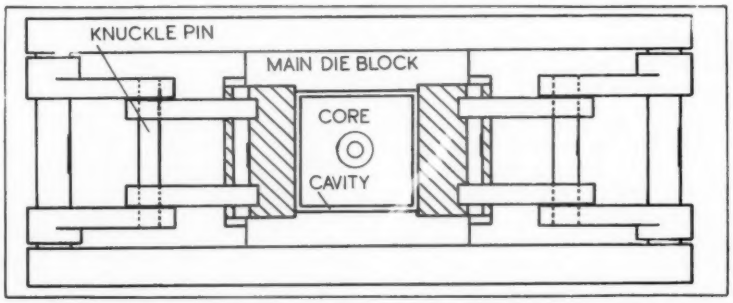


Fig. 3.—Toggle-locks on opposed cores; the method is avoided because it renders the die heavy and cumbersome

One which is particularly adapted to massive, short-stroke cores—especially when mounted in opposed pairs—is the toggle movement illustrated in Fig. 3. This also is applicable only to cores housed in the moving die member. The die is of built-up construction with the cavity insert and core mounted between two extended arms which project beyond the die-base to which all are secured. The arms act as guides for the two massive cores, which are each composed of a steel face-piece, abutting upon and partly entering the cavity insert, and a cast-iron block with integral trunnions. The blocks are hollow to reduce the weight of the assembly. At each end of the die a shaft is held between the projecting arms and carries the toggle-links; these are provided with a common knuckle-pin. The whole toggle assembly is sufficiently massive to eliminate the need for any wedges or other auxiliary locking devices. Initial adjustment of the locking pressure is obtained by shimming the joint between the core-face elements and the cast-iron core bodies.

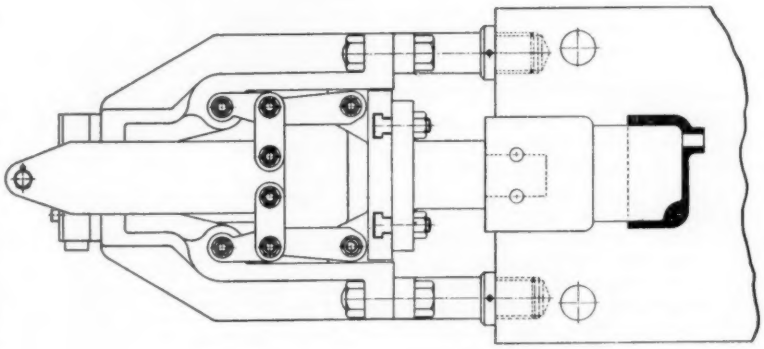
In operation, the fixed platen is provided with two adjustable stops which contact the knuckle-pins as the die is closing; these are set to bring the toggles to dead-centre as closure is completed. When the die is opened after injection, the two core-blocks remain engaged with the casting during the first part of the withdrawal stroke. Before the ejectors come into action, however, the knuckle pins engage a pair of stops mounted on the machine frame, breaking the lock and drawing the cores free of the casting. The latter may then be ejected; if push-rod ejection is used, the core blocks continue to move back during the ejector stroke. Actually, it is commoner with such dies—which are in the nature of the case used only for the production of large, box-like components—to use either rack-and-pinion ejection or, of recent years, to provide an auxiliary ram in the moving platen to actuate the ejector-plate. With either of these methods the designer can make use of the last inch or two of the opening stroke to withdraw the lateral cores, and these accordingly retract only sufficiently to bring them clear of the diecasting. It is thus possible to make use of short-link toggles, with a consequent reduction in overall dimensions and a gain in rigidity. Although very effective for short displacements, toggles with short links become much less efficient as the included angle between the links decreases; it is therefore advantageous to avoid excessive movement of the core once it is clear of the component.

The movement as here described can be used only for actuating cores in the ejector half of the die, since it is the movement of the latter which locks and unlocks the toggles. The merits of toggle action, however, are at least as evident in the case of castings formed mainly in the fixed die member; the majority of box-like components are in fact so formed. By rendering the toggle action independent of the die movement, the cores can be housed in either die half, and this can be achieved by using hydraulic cylinders to make and break the lock. The cylinders, of course, need only be small, since they utilize only a fraction of the power required by an equivalent direct-acting core-pull.

In its main constructional features such a set-up does not differ greatly from that of Fig. 3, though it is necessary to provide in addition a fixed mounting for the cylinder. The ram of the latter is pivotally secured to the knuckle-pin of the toggle.

In the past, the use of combined hydraulic (or pneumatic) and toggle link core-pulls has been limited to relatively large dies, primarily because only these could justify the added constructional costs, but partly because for dies of medium size there is a wide choice of purely mechanical

Fig. 4.—Pulling a side core in a diecasting die with a "Kennard" toggle ram

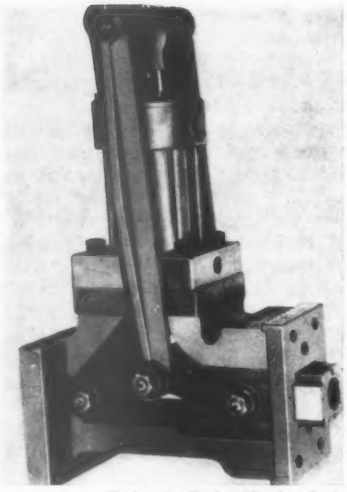


methods of core withdrawal. Other things being equal, mechanical actions have the general advantages of being self-contained, free from the possibility (in most cases) of sequence errors, and of not requiring to be looped into the control circuits of the machine. Dies with mechanical movements can, accordingly, be moved with much greater ease from one type of machine to another. Nevertheless, this factor is of decreasing influence today when heavy-duty hydraulic machines are becoming standard in every shop.

It is of interest, therefore, that self-contained core-pulling units embodying a toggle-action actuated by a pneumatic or hydraulic cylinder have recently been made available commercially, for the advantages of the method can now be made use of in smaller dies. The security, the low stresses at withdrawal and the possibility of fitting to either die half at will—all these are retained, but the construction of the movement as a complete unit (Fig. 4) interchangeable from die to die, makes possible appreciable simplifications in the construction of the basic tool. In particular, less massive core-blocks are required and this, for reasons already outlined, often makes it feasible to reduce the overall die-block size.

The toggle ram, as this mechanism is termed, is perhaps better suited to the specific requirements of core-pulling than any other of the means currently in use, for it provides an enormous intensification of effort at the beginning of the stroke (Fig. 5). The larger models, for example, exert an initial pull of approximately fifteen tons for the standard line pressure of 1000 psi. There is thus ample power available for stripping the core from the casting. Moreover, the reactive thrust is confined to the member housing the core; in this respect the toggle ram is superior to the conventional finger-cam mechanism, where the reaction is taken by surfaces in sliding contact and has a net tendency to displace the die members laterally.

Because of the positive lock afforded by the toggle, it is not necessary to provide wedge-locks or other means of preventing the core from moving back under injection pressure when a toggle ram is fitted. The device also permits great flexibility in locating cores, as compared with finger-cam movements. The latter operate best—and are most easily fitted—in the plane of the die-parting or parallel thereto. It is possible, without much difficulty, to operate cores having five or ten degrees of obliquity, but tilts greater than this are difficult to accommodate successfully. The toggle ram, by contrast, can be mounted at any desired angle, and works with equal efficiency in every position.



Engineering Tool and Product Design Company Limited

Fig. 5.—Another type of toggle ram in which the actuating cylinder is at right angles to the direction of pull. Two sizes are made, giving strokes of 1 in. and 1½ in.

NYLON TUBING FOR LUBRICATORS.—The latest demonstration of the use of synthetic fibres in industry is provided by Wakefield-Dick Industrial Oils Limited, who now market and fit "Nylon H" tubing when required, to their mechanical lubricating equipment. This tubing, being completely flexible, can be rapidly installed in awkward and inaccessible positions, and will withstand pressures of up to 2500 psi. The tubing is subjected to testing at 77° F and is guaranteed against bend strain and damage by impact and will not become brittle within the prescribed temperature range (—74° C to 105° C). Wakefield-Dick supply "Nylon H" tubing in five sizes, with outside diameters from 0·125 in. to 0·375 in., and inside diameters from 0·078 in. to 0·225 in. respectively

100g Vibrator

A new environmental test vibrator specially suitable for high "g" valve and component testing, extended fatigue tests, and accelerometer calibration, is now being marketed by E.M.I. Electronics Limited. Known as the EMV 100A, this instrument has been developed to meet the long-standing requirements for a vibrator with a frequency range with full thrust extending to 20,000 c/s. Its usable frequency range covers 1-20,000 c/s, and continuous rating thrust is maintained throughout the range of 30-20,000 c/s.

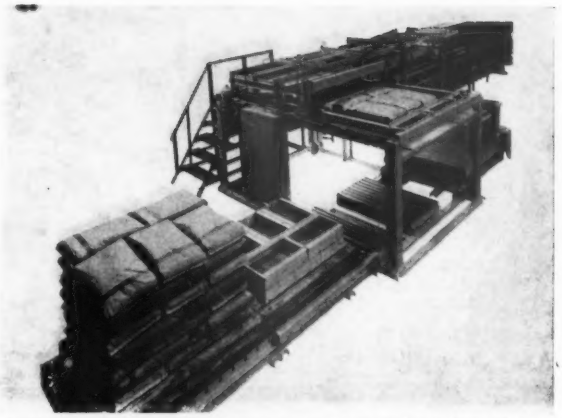
It offers 100g peak, and when used with "white noise" and a peak to r.m.s. ratio of 3:1 the corresponding g figures are 212.1g peak and 70.7g r.m.s. The vibrator which is completely self-contained, is stressed to give over 100% safety factor when used under these conditions.

During reliability trials the vibrator performed 1,000 million reversals at 100g level fixed frequency and 1,000 million reversals whilst being swept in frequency from 100 to 5,000 c/s at 100g level. It also carried out 200 million reversals at 500g, a performance that indicates its extensive capabilities. The reliability trials are being continued in an effort to determine the life of component parts. So far no failures have been recorded.

Adhesive for PVC/Metal Lamination

The B. B. Chemical Company Limited of Leicester which manufacture the Bostik range of adhesives and sealing compounds, has installed an experimental laminating line in their Research and Development Laboratories to finalize development of a special adhesive for laminating PVC to metal by a continuous process. An adhesive has been developed which produces a strong, permanent bond between the plastic and the metal over the laminating temperature range of 170° C—200° C. The resultant laminate can be fabricated exactly as the base metal and deep drawn without damage to the plastic or the adhesive bond.

Eventually it is expected that laminates of this type will supersede many other forms of metal finish in products where a decorative finish is desirable.



The Western fully automatic pallet loader can handle and stack both bags and boxes. The production line feed is at the top and to the centre right is the dispenser which feeds the machine with empty pallets. The centre section stacks the bags or boxes and delivers them, fully laden to the roller-conveyor at bottom

Automatic Pallet Loading

The Materials Handling Division of Western Manufacturing (Reading) Limited have completed their development programme and are now producing a range of fully automatic pallet loading machines. Originally developed and produced in conjunction with the engineers of the Plastics Division of Imperial Chemical Industries Limited, the equipment has been in service in various plants of that company for some considerable time. The machine is capable of handling bags, sacks, crates or cartons with equal ease and will cope with any product which is normally palletized.

Due to the accuracy of automatic loading, the storage of the precision pallets enables higher stacking than can be safely achieved by orthodox means. It is possible to conserve up to 50% of the normal storage space, and with modern bulk production methods the annual saving amounts to many thousands of pounds.

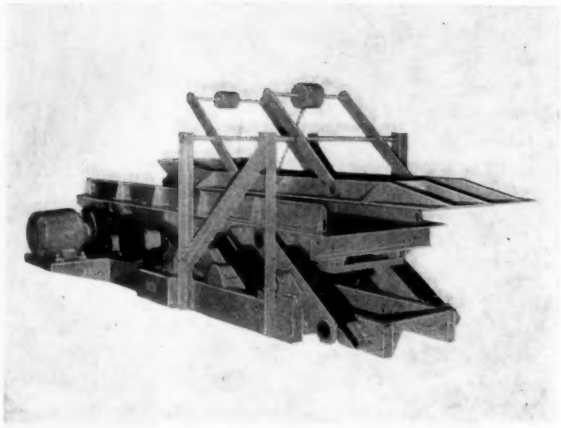
The speed of the machine is easily adjusted to suit a variable production rate and the machine requires no special operator and can be supervised by the fork lift truck operator who attends to the removal of the loaded pallets.

The machine takes charge of the sacks or containers direct from the production line. It then uniformly arranges them into any desired pattern on the pallet. The process is continuous until the pallet is fully loaded. The loaded pallet is then automatically ejected to an off-load section from which it can be directly handled by fork lift trucks. Associated with the machine is a pallet dispenser—a magazine containing empty pallets which automatically feeds the machine.

When the pallet loading machine is handling bags or sacks, these are passed through a vibro-flattening unit prior to the pallet loader, thereby ensuring uniformity. Associated equipment such as the vibro-flattener, powered roller conveyors and the empty pallet dispenser, etc., can be fitted to existing systems.

Improved Deseaming Machine

A deseaming machine of an improved design, the first to have continuous orifice burners, has been installed in the Bilston works of Stewarts and Lloyds, Limited. The machine deseams all four sides of a bloom simultaneously.



This vibro-flattener unit is normally used in conjunction with the automatic pallet loader when it is handling sacks. It can be used independently of the loader in the production line

The deseaming process, a method of eliminating surface defects from hot steel blooms, involves the removal of the surface metal. This results in a continuous production of molten slag, and a feature of the new machine—the Lin-De-Surfacer (Type CM-27D)—is its ability to granulate the slag with water jets, thus protecting the rolls from spatter. Stewarts and Lloyds, Limited, Bilston, are the first company in Britain to install a deseaming machine with continuous orifice burners.

Designed to deseam hot steel blooms by the oxy-acetylene process at the usual rolling temperatures, the machine accomplishes the operation by means of fully automatic deseaming units which are articulated so that they will maintain a fixed relationship with the bloom surfaces even though the bloom may have some vertical or horizontal camber.

The machine is mounted upon a motor-driven carriage installed transversely to the roll table line, and rides on rails located to allow the machine to be positioned in line with the roll table or to permit its withdrawal for inspection. It is controlled from a desk and the operating cycle is governed entirely through electrical timers, initiated by the operator.

The machines can be used on blooms ranging in size from 2 in. × 4 in. to almost 22 in. × 11 in., and the surface metal can be removed to a predetermined depth of up to $\frac{1}{8}$ in.

Manufactured by the Linde Company, a division of the Union Carbide Corporation of Newark, New Jersey, the machine is sold in this country under licence by British Oxygen Gases Limited.

New Worthington-Simpson Pumps

Worthington-Simpson Limited, of Newark, Notts, announce an addition to their already extensive range of versatile "Monobloc" centrifugal pumps. The new range is designated type "DO" and comprises open impeller type pumps specially designed to handle slurries, paper stock, liquids containing small solids, and viscous liquids as well as clear liquids. Capacities of from 10 to 360 gpm and heads up to 86 ft, depending on capacity, are covered by this range of pumps.

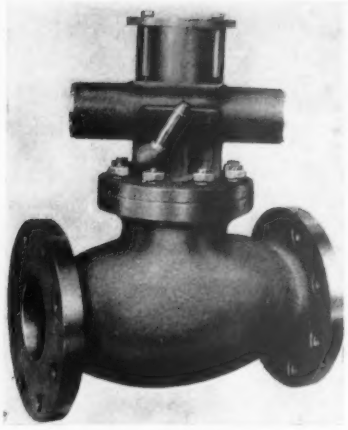


Fig. 1.—Typical ON/OFF pneumatic valve

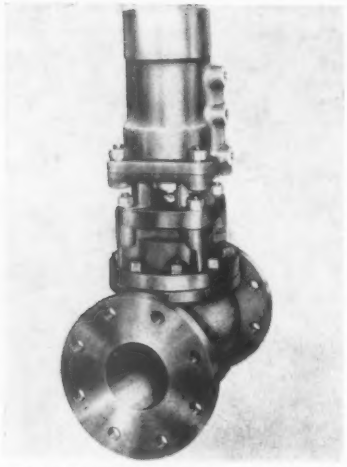


Fig. 2.—Typical variable opening pneumatic valve

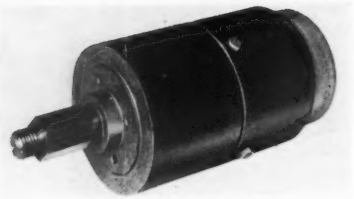


Fig. 3.—Industrial positioner

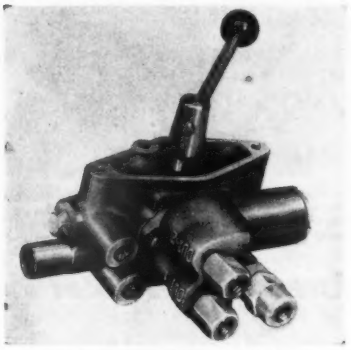


Fig. 4.—Forward/Reverse selector

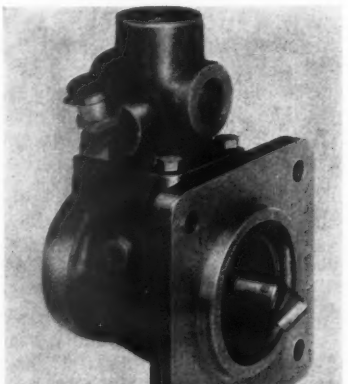


Fig. 5.—Standstill detector

Pneumatic Control Equipment

Five new pieces of pneumatic control equipment have been added to the range marketed by the Westinghouse Brake & Signal Company Limited, 82 York Way, King's Cross, London N1. They comprise "Pneuvalves", industrial positioners, "Rotorseals", a selector switch, and solenoid operators.

The range of Pneuvalves Figs. 1 and 2 consists of pneumatically-operated remotely controlled globe or marine type valves ranging in size from ½ in. to 6 in. Alternatively, the pneumatic operator can be supplied separately for modification of existing hand-operated valves.

Pneuvalves are available in two categories: (a) Open/Shut, which operates on an "over-centre" principle and thus the air supply may be released after the valve has functioned; a variable opening type which enables any degree of valve opening to be achieved remotely at the touch of a finger. These valves are designed for low pressure (100 psi) and are suitable for gas, air, sea water, lubricating oil, fresh and bilge water, fuel oil and distillates.

Pneuvalves can be controlled from any distance by a variety of arrangements. Normal distances, as found for instance, in most marine installations, use only small bore copper or flexible plastic pipe and are generally operated by simple hand or foot valves which (in the case of hand valves) can be mounted together in a control desk or pedestal.

The operation of Pneuvalves over greater distances—especially where instantaneous or synchronized operation is required—can be carried out with the assistance of Westinghouse solenoid valves which can be operated remotely be an electrical signal.

On the Open/Shut type valves, an attachment can be supplied which gives an electrical signal back to the control point to indicate whether the valve is open or shut.

The new industrial positioners (Fig. 3) are a range of spring-balanced diaphragm positioners designed to meet many industrial requirements, where sensitive positioning of items such as engine governors and throttles is required. These positioners combine the constant area characteristics of a cylinder with the low friction features of a diaphragm design. The positioners are normally supplied with a threaded end to the operating rod, and are designed for "bolt on" spigot mounting.

Pressure ranges and work ratings are as follows:

	Work rating	Pressure range
Type 12D	72 in./lb	0–25, 0–50, 0–80 psi
,, 36D	388 in./lb	0–50, 0–80 psi
,, 50D	600 in./lb	0–50, 0–80 psi

In order to satisfy a demand for a foolproof system of gearbox operation on such vehicles as locomotives or railcars. Westinghouse has perfected a new selector switch (Fig. 4). Used in conjunction with the Westinghouse standstill detector (Fig. 5), this selector ensures that a change in drive direction cannot take place until the vehicle is stationary.

The function of the standstill detector is to determine whether or not a shaft is in motion. This is accomplished by means of an air valve, which either retains or exhausts air pressure depending upon whether the shaft is stationary or in motion. According to the particular installation, so the detector air supply can be used to operate an electro-pneumatic switch, for instance, and so provide a safety interlock. A typical application is to prevent a directional gear change on a railcar from being operated until the railcar is at a standstill.

The Forward/Reverse valve is intended for installation in a control desk and in addition to normal

Fig. 6.—Solenoid operator

selection of forward or reverse, the combination of the two units provides the operator with complete protection against damage due to incorrect judgment of speed when selecting a directional change on, for instance, the forward/reverse gearbox of a locomotive or railcar.

However, this valve can be used for many installations where it is desired to "prove" one circuit before applying air pressure to one or other of two delivery lines.

This valve is provided with a pneumatic lock (operating in conjunction with the standstill detector) which provides a locked zone of handle movement thus preventing a gear change from being made unless the standstill detector indicates that the appropriate shaft or axle is at zero speed. Operation of the gearchange is accomplished by one or other of two air signals supplied by the valve in accordance with handle position.

The valve can be supplied with electrical contacts in place of the pneumatic portion when electrical operation is required. The pneumatic lock is identical on both the electrical and pneumatic types of valve.

Recent additions to the Westinghouse range of solenoid operators (Fig. 6) for their D-type On/Off spool valves, include the following voltages for d.c. supplies: 24V, 32V, 50V,110V, 200V.

Dual-purpose Twin-zone Heaters

Twin-zone radiant heaters, designed to give either a concentrated or a widespread warmth from the one unit, have been developed by The General Electric Company Limited. The variation of heat intensity is effected simply by raising or lowering an aluminium reflector within the body of the heater; the distance the reflector is positioned from the elements governs the width of the beam of heat.

With the reflector in the narrow beam position, the heaters are ideal for providing warmth over isolated sections of buildings such as loading bays, hangars, machine shops and garages. In the broad beam position the heaters can be used for complete heating installations in churches, village halls, community centres and similar buildings where overall air heating would be too costly due to intermittent use or lightness of construction of the building.

Running costs are at a minimum because warmth is concentrated only where it is needed and the heaters need only be switched on a short time before a building is used.

The frame is made from 20-gauge sheet steel and finished stoved enamel bronze. It incorporates a 20-gauge aluminium reflector and long-life Incoloy sheathed wire element(s). The 1½ kW model is fitted with a single element and single trough reflector and the 3 kW model with two 1½ kW elements and a double trough reflector. A wire guard to clip on to the underside of the heater is available and a top guard can also be supplied to prevent lodgement on the top of the reflector. The reflector is easily removable for occasional cleaning with a damp cloth to maintain maximum reflectivity.

A single 3 kW Twin-Zone heater adjusted to the narrow beam position and suspended horizontally at a height of 12 ft above floor level will give an intensity at average shoulder level of approximately 45 B.th.u per sq ft per hr. If the 3 kW heaters are adjusted to the broad beam position and mounted at 14 ft from floor level, 16 ft to 13 ft between rows and 10 ft between centres, a uniform intensity of approximately 30 B.th.u. per sq ft per hr will be obtained at shoulder level.

Both the 1½ kW heater (Cat. No. HO 6434) and the 3 kW heater (Cat. No. HO 6435) measure 44½ in. long × 6⅜ in. wide × 2⅜ in. deep and have 40¾ in. fixing centres. The 1½ kW heater is priced at £7 10s. 0d. and the 3 kW heater at £9 2s. 6d. (Twin-Zone heaters are not designed for domestic use and are therefore not subject to purchase tax).

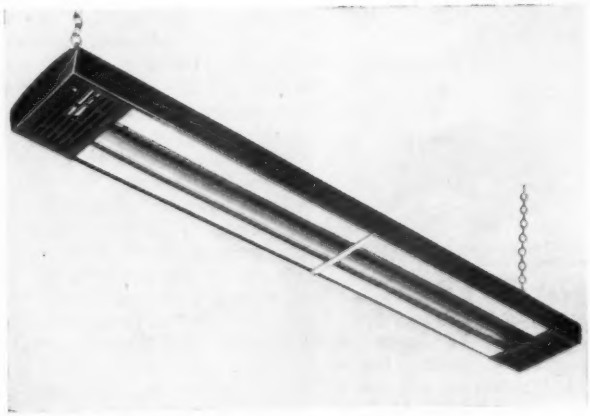


Fig. 1.—1½ kW version of the new G.E.C. twin-zone radiant heater

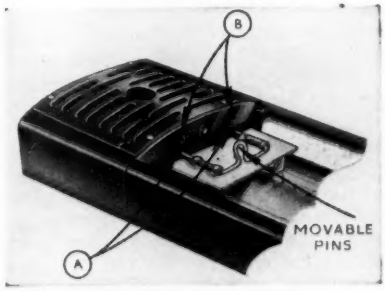


Fig. 2.—The distance of the reflector from the infra-red elements is easily adjusted, "A" shows the narrow beam position providing concentrated warmth over isolated sections of large buildings. "B" shows the broad beam position giving a widespread zone of heat for complete heating installations

Microptic Precision Clinometer

The Hilger & Watts range of optical-reading clinometers has been extended by the introduction of the Microptic precision clinometer (TB 90), which reads direct to 1 second of arc, with estimation to 0·5 sec, over an angular range of 0–360°.

It is suitable for inspecting angular surfaces and gauges, for locating jigs and fixtures, and for setting inclinable tables on jig-boring machines and angular work on grinding and lapping machines. Inclinations are measured by reference to the horizontal plane, indicated by an incorporated spirit-level. Repetition of bubble settings to 1 second of arc is ensured by an optical coincidence-reading system and a slow-motion setting control.

The circular glass scale is totally enclosed and the micrometer microscope eliminates any eccentricity effects in the circle by automatically averaging sub-divisions made on two sides of the circle. The microscope eyepiece is inclined at an angle of 45° and is rotatable for convenience in viewing.

The steel base of the instrument is lapped, with two sides square to each other for reference purposes. Three lapped supports on the back of the clinometer enable it to be used in the horizontal position. Optional accessories are a work-table for measuring angular displacements of small parts, and an adjustable reflector which, in conjunction with an autocollimator, can be used for setting out angles. Both accessories are interchangeable with the spirit-level unit.

The microscope-reading system and the spirit-level are illuminated by separate low-voltage lamps.

New Clamping Jig

A new clamping jig, the "Cone-Lok", utilizes the highly effective locking power of perfectly mated cones. One is formed on the horizontal pinion shaft and fits the other which is an integral part of the base. Two sets of cones are employed, one on each end of the pinion shaft, the smooth locking action being transmitted by helical gear and rack. There are five models in eighteen sizes from 1 in. × 1 in. to 12 in. × 9 in. work areas with interchangeable heads and trays.

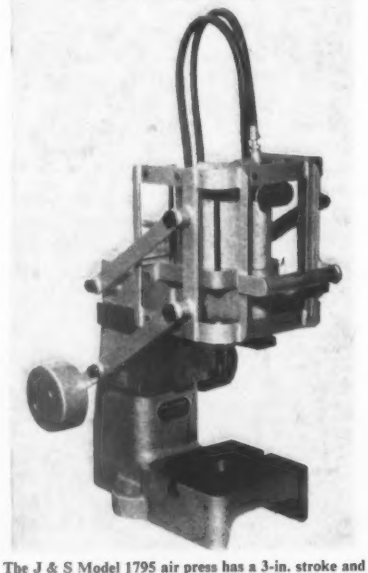
Among the advantages of the "Cone-Lok" are the few parts and consequently low maintenance and

The new "Cone-Lok" clamping jig. There are five models and 18 sizes

low lost time. No special tools or skill are needed for the rapid assembly or dismantling. A sealed system ensures adequate lubrication of the moving parts and keeps out chips, cutting oils, etc.

Working parts cannot be moved without actuation of the operating lever and the tray is positively clamped into position in up or down stroke. Any excess load on tray instantly throws a second "Cone-Lok" into action, securely holding tray in the original position.

The manufacturers and distributors are F. Pratt & Co. Limited, of Halifax, who are making the mechanism under licence from the N. A. Woodworth Company, of Detroit, U.S.A. During the introduction of the new jigs they are available for ten-day free trail.



The J & S Model 1795 air press has a 3-in. stroke and gives a ram thrust of 1317 lb]

3-in. Air Press

A new air press, Model 1795, introduced by A. A. Jones & Shipman Limited, Leicester, has a 3 in. stroke and at 100 psi will give a ram thrust of approximately 1317 lb, and at 80 psi a thrust of 1053 lb. The ram cannot descend until the guard completely covers the work-table and both descent and return velocities are controllable by adjusting two separate throttle valves attached to the main valve block.

The cylinder head is adjustable over 2 in. for increments of 1 in. and has a maximum air gap from work-table top to the underneath side of the ram of $7\frac{7}{16}$ in. To reduce fatigue the guard is counterbalanced.

The ram is bored with a hole of $\frac{1}{2}$ in. $\pm$·00025 dia and the work table has a centre hole of $1\frac{21}{32}$ in. dia. in addition to a standard $\frac{1}{2}$ in. T-slot.

Electronic "Building Bricks"

A comprehensive series of electronic sub-assemblies designed as standard "building bricks" for the construction of industrial control systems, digital computing elements, data processing equipment, measuring systems and other equipments based on digital circuit techniques, has been introduced by Mullard Equipment Limited, Torrington Place, London WC1.

Two ranges are available: "Norbits" and "Combi-Elements". Norbits have been developed primarily to allow industrial firms to build their own sequence control systems quickly, economically and without the services of trained electronic engineers. They can also be used as standard building bricks by electronics firms specializing in control systems. The range includes all the appropriate circuit elements for the construction of machine tool and transfer line controls, factory safety systems, automatic lift controls, sequential programming systems and so on.

Combi-Elements are intended specifically to provide the manufacturer of electronic systems and equipment with a set of standard building bricks representing the most commonly-used digital circuits. Besides cutting down development time and costs, their use leads to substantial savings in space and affords greater flexibility in the building of larger systems and equipments. Apart from their applications in the manufacture of production equipments Combi-Elements can be used advantageously in the construction of laboratory measuring and test equipments.

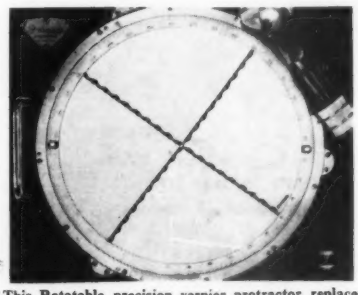
To ensure a high standard of reliability both types are transistorized throughout.

Shadomaster Protractor

A new precision vernier protractor for use with the standard Shadomaster projectors Models VMP, CRP and CRP MK II, has a high degree of accuracy and incorporates a number of novel features. It consists of a rectangular cast frame with a rotatable circular screen $9\frac{3}{4}$ in. dia. In use, the normal etched glass screen is lifted out of the projector screen frame and replaced by the protractor. An adjustment is provided so that the protractor may be set parallel with the traverse of the workstage.

The main scale ring, which also carries the Shadoline screen, is located by three pre-loaded precision rolling bearings unequally spaced to eliminate the possibility of the track becoming patterned after much use. It has half degree divisions, numbered at 10° intervals, from zero to 180° in both directions and the vernier scale ring has $14\frac{1}{2}$° divided into 30 divisions on each side of zero, thus allowing direct readings in minutes in either direction; both rings are divided on a Societe Genevoise dividing engine to within a maximum total error of ± 10 seconds of arc. The vernier scale does not touch the main scale ring, eliminating another possible source of inaccuracy which could occur through wear.

The Shadoline Screen itself provides a "line of no thickness". The cross lines consist of translucent colour bands at right angles, with one edge coincident with the theoretical centre lines of the protractor. The other edges of these bands are deckled in order that there may be no confusion as to which side of the band to use. Since the image, or shadow, can be viewed either through the clear portion of the screen or through the translucent bands, the working edges of these bands provide, in effect, continuous lines having no width.



This Rotatable precision vernier protractor replaces the screen on the Shadomaster projector

The makers of the Shadomaster are Watson, Manasty & Co. Limited, 139 Richmond Road, Kingston-on-Thames.

"LIFTMASTER".—Extensive trials of the Liftmaster circular lifting magnet in steelworks and foundries over a period of four years have now been completed. Of welded construction and moisture proof, it offers dependability and a greater pick-up for nominal diameter, and the peripheral face is free from projections. For the present the makers, Rapid Magnetic Machines Limited, Lombard Street, Birmingham, are producing it in three sizes, 52 in., 62 in., and 72 in.

The Apwar edgefinder uses light combinations from illumination ports to indicate the edge of a workpiece to a high degree of accuracy

Edge Finding Instrument

The new "Apwar" edgefinder is designed primarily to locate accurately the machine spindle centre line in relation to the edge of the component to be machined. The relative position is given to within 0·0002 in. and is secured by automatic light combinations observed by the operator from illumination ports in the body of the instrument. The source of power for illumination is derived from a torch battery enclosed within the instrument.

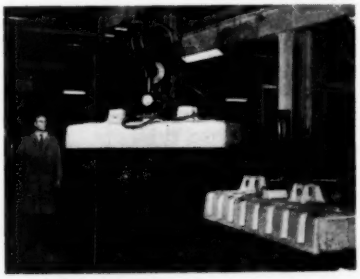
The instrument has a $\frac{3}{8}$ in. dia parallel shank and may therefore be used in a drill chuck, lathe chuck or collet, or any tool-holding device capable of accommodating the shank. It is not necessary for the body of the instrument to run absolutely true, any chuck in reasonable condition will, therefore, give the desired results. The instrument is made by A. P. Warren Limited, 37 Sheen Road, Richmond, Surrey.

A standard torch battery is contained within the body of the instrument and electrical continuity necessary to provide illumination behind the ports in the lower portion of the instrument is obtained via the shank, the machine, the workpiece and the protruding heads of self-adjusting contact pins.

Two pins are set at right angles, providing four contact heads located on a common plane at intervals of 90° round the body of the instrument. The contact pins are hardened and their lengths are rigidly controlled.

Above each protruding contact head is an illumination port emitting red and green signal lights alternately, the length of the pin adjacent to the red ports having a "plus" tolerance, the other a "minus" tolerance. In use the machine spindle is rotated slowly whilst the work edge is fed towards the edge finder. When initial contact is made a red light signal appears. Feed and spindle rotation is continued whilst the operator observes pin contact condition as revealed by the illumination ports. When two red light contacts and one green occur during one complete revolution the spindle centre is 0·5 in. (± 0·0001 in. under extreme conditions) from the edge of the workpiece.

Excess table feed is instantly revealed by illumination occurring at all four contact points during one complete revolution of the spindle.



MAGNETS FOR RAILS.—Nearing completion at the Bedford Works of Brookhirst Igranic are these new-type magnets designed specifically for the lifting of railway lines or steel bars. Used in pairs on a 30-ft spreader bar, the magnets will lift up to 17 light rails at a single hoist. The two in the picture are to be shipped to the Tata Iron & Steel Company's Jamshedpur mill in India which used to be supplied from U.S.A. or Germany

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Mathematical Analysis. By Edwin M. Hemmerling. New York, 1959; McGraw-Hill Book Company Inc. London: McGraw-Hill Publishing Company Limited. 45/- net (by post 46/3). 332 pp. 5½ × 8¼ in.

Many people attempt the study of mathematics in these days as part of a technological course, and their starting point is dictated by the needs of the other subjects in the course. They are presumed to have a sound knowledge of fundamentals, but the truth is that not all have had the urge to acquire this while the opportunity offered. When they realize this they go back and make up the shortcoming, and if they use the regular preliminary books then they take a lot of time over it and suffer some frustration. Fortunately some of the mathematical texts prepared specially for use with technological courses make provision for this lack by having an introductory section designed to provide the necessary background. The new book under notice does this quite thoroughly and manages to cover a lot of ground sufficiently adequately and with examples and exercises. The purpose is to lead up to the calculus with a proper understanding. Particular emphasis is given to the analytical relationship between trigonometric functions, inverse function rotation is frequently used, and emphasis laid on dimensional accuracy in equations. Finally graphical analysis and the limits of a variable lead to a brief introduction to calculus.

The Diesel Engine. By L. V. Armstrong and J. B. Hartman. New York, 1959; The Macmillan Company. 45/6 net (by post 46/8). 360 pp. 5½ × 8¼ in.

While a single, comprehensive book on a subject is no substitute for the understanding gained from the wide reading of various authors, it nevertheless has its uses, particularly as an introductory text. There is always a limit to detail in such treatments and rather more is possible with a narrowly defined subject than with one that ranges widely. One would have thought that the diesel engine offered this compactness, but closer examination shows a number of special aspects, such as vibration and economics. The authors of this book have been successful in their attempt to survey the whole field while at the same time dealing with sufficient detail to provide a whole picture. They cover combustion in the diesel engine; the dynamics and statics of the machine; such topics as supercharging, speed control and starting; and costs and application. Much of what is presented is in the form of results—formulae and the like—which gives something of a handbook character to the text, but that will suit many a purpose and in any case the concise treatment is worth having.

books

Industrial Building Details. By Duane F. Roycroft. New York, 1959; F. W. Dodge Corporation. $12·75 net. 352 pp. 8¾ × 11½ in.

The modern trend is to build factories in or near urban areas where the style of building has to be acceptable in relation to the environment. The author of this book has been engaged on work of this kind since 1937 and from his experience presents the reader with a host of details, all taken or adapted from actual construction drawings. There is comparatively little text, the large pages being given over almost entirely to drawings, many of them to scale and often with dimensions. Covered in this way are structural details, walls and windows, louvres, roofs and parapets, monitors, floors, ventilators and stack curbs, expansion joints, flashing, canopies, doors and door frames, stairs and landings, ladders and platforms, hatch covers and frames, catch basins and manholes, storage and transport. The book, being concerned exclusively with industrial buildings, will be of as great value to the engineer as to the architect. It will be useful, too, in the maintenance department where the staff have to attend to building alterations as well as look after the machinery.

Tables of the Exponential Integral for Complex Arguments.—In the National Bureau of Standards Applied Mathematics Series 51, (Price $5·63 from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.), the function

$$E_1(z) = \int_z^\infty (e^{-u}/u)du,\ z = x + iy,$$

is tabulated to six decimal places, for $0 \leqslant x \leqslant 4$, $0 \leqslant y \leqslant 10$, with intervals between the arguments so chosen that quadratic interpolation will yield six place accuracy over most of the region. Also tabulated is $E_1(z)$ to ten decimal places over the region $0 \leqslant \neg x,\ y \leqslant 3{\cdot}1$ at intervals of 0·1. To facilitate interpolation the function $E_1(z) + \log z$ is tabulated for $0 \leqslant x,\ y \leqslant 1$ to six decimal places and for $0 \leqslant \neg x,\ y \leqslant 1$ to ten decimal places. For the region $4 \leqslant x \leqslant 10$, $0 \leqslant y \leqslant 10$ the auxiliary function $e^z E_1(z)$ is tabulated to six decimal places since interpolation for the same number of significant figures is easier for this function than for $E_1(z)$. Finally, a short table of $e^z E_1(z)$ over the region $0 \leqslant \pm x,\ y \leqslant 20$ is given to six decimal places over varying intervals.

The exponential integral is a basic mathematical function and its tabulation is of fundamental importance to mathematics and physics. The Bureau states that as far as is known the material in this volume is completely original. The range and the tabular intervals have been chosen to suit the needs and convenience of users in the physical sciences. The initial preparation of the tables arose in connexion with needs in atomic research. However, the tables have found applications in many other fields, for example, in fluid dynamics, in the study of turbine characteristics, and in the theory of diffusion.

Tables of Osculatory Interpolation Coefficients.—National Bureau of Standards Applied Mathematics Series 56 by H. E. Salzer, (38 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.), presents tables which supplement previous tables of interpolation coefficients published in the Bureau's Applied Mathematics Series. However, the accuracy obtainable with the use of osculatory coefficients in interpolating for functional values is considerably greater than with other formulas of equal complexity, hence these tables will afford a significant saving of computation time and effort for scientists in mathematics and in all branches of physics, and for all engineers, especially those in the fields of aeronautical engineering, electrical engineering, gas- and hydrodynamics, as well as others.

The tables give the coefficients $A_i(p)$ and $B_i(p)$ where

$$f(x_o + ph) = \Sigma \{A_i(p)f_i + B_i(p)hf_i\}$$

between the limits $i = \frac{1}{2}(n-1)$ and $\frac{1}{2}n$

for $n = 2(1)5$

and $p = -\frac{1}{2}(n-1)(0{\cdot}01)(\frac{1}{2}n)$

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exact values or nine decimal places. These coefficients facilitate interpolations when both a functional and its first derivative are tabulated.

Mathematical Tables.—The U.S. National Bureau of Standards has published tables of the bivariate normal distribution function and related functions. The tables and introductory material are the most complete and exhaustive reference available on the bivariate normal distribution function. The work is a compilation and extension of the tables of Karl Pearson, Evelyn Fix and Jerzey Neyman, and H. H. Germond. Included in the volume are an introduction describing the mathematical properties of the functions and outlining interpolation techniques, and an extensive section on applications of the tables. Among the applications mentioned are evaluating measurement errors in a calibration system, calculating integrals over polygons with respect to bivariate normal distribution, heat flow problems, and problems in psychology. The volume is "Applied Mathematics Series 50", and the price by post is $4·06 from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.

Training Industrial Designers.—A source of reference for U.K. manufacturers and educationalists concerned with the problem of producing competent industrial designers is provided by a 60 page booklet published by The Federation of British Industries. "The Training of Industrial Designers (Engineering)" is the report of a conference at which the subject was discussed by leading industrialists and educationalists. "An Industrial Designer" the report says, "is responsible, in collaboration with engineers and others, for the appearance, and convenience of operation and maintenance, of those products and equipment made by engineering processes." Manufacturers in search of competent designers are faced with a difficult choice. Should they seek artists with engineering knowledge or engineers with artistic ability?—both rare combinations the report suggests. The answer to the problem educationalists say is to turn out more industrial designers specifically for the job. The role of technical colleges in this connexion is discussed.

The Booklet is obtainable from F.B.I. Print Publications, 21 Tothill Street, SW1. Price 5/- post free, excluding airmail.

Industrial Solvents and Flammable Liquids.—The Fire Protection Association has published a revised edition of its booklet "Industrial Solvents and Flammable Liquids" which first appeared in 1954. Intended primarily as a work of reference, the booklet is set out in tabular form and provides information on the physical properties of some 400 liquids. The information on flash points and flammability limits has been extensively revised, while the alternative names of some liquids are now incorporated in the main table. The edition also contains a temperature conversion table. Copies are obtainable from the Fire Protection Association, 31/45 Gresham Street, London EC2, price 3/-.

Adhesives Guide.—Enquiries are frequently received by the British Scientific Instrument Research Association from its member firms for information about adhesives. An "Adhesives Guide" has accordingly been prepared by the association as a handbook to cover this ground. The contents include notes on the selection of adhesives for particular purposes, summaries of the properties of more than 50 main types of adhesive, tabulated data on 400 individual adhesives made by about 100 firms, and an index of trade names. The guide is obtainable post free from British Scientific Instrument Research Association, South Hill, Chislehurst, Kent, price 20/- in U.K., and 22/6 abroad.

Smokeless Boiler Operation.—A series of articles on the smokeless operation of industrial boiler plant by authorities from the British Coal Utilisation Research Association, the Fuel Research Station, and industry, have been reprinted from "The Steam Engineer" in the form of a 52-page booklet which is available from John D. Troup Limited, 90 High Holborn, London WC1, price 10/- post free. The subject is dealt with in the light of the Clean Air Act, the particular aspects being combustion in fuel beds, hand-fired shell boilers, mechanical firing, pulverized fuel in shell boilers, measurement of smoke and grit emission, and grit and dust collection.

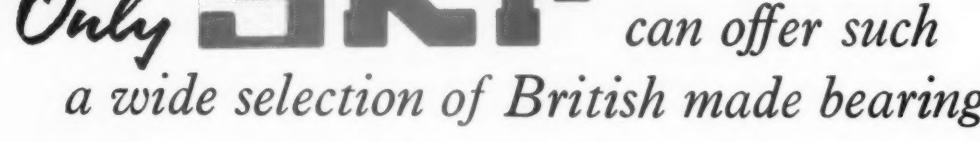
Technology and Education.—A bibliography of the effects of technological progress on education has been published by The Institution of Production Engineers, 10 Chesterfield Street, London W1, price 14/6 net (by post 15/6). It has been compiled from British sources of the period 1945–57 and while not comprehensive, is intended to be a guide to the development of technical education during the period covered. Independently of its use as a bibliography, it should serve as a summary of opinion on the subject. It is very likely the only bibliography of its kind issued. It has been prepared by the Institution's Hazleton Memorial Library.

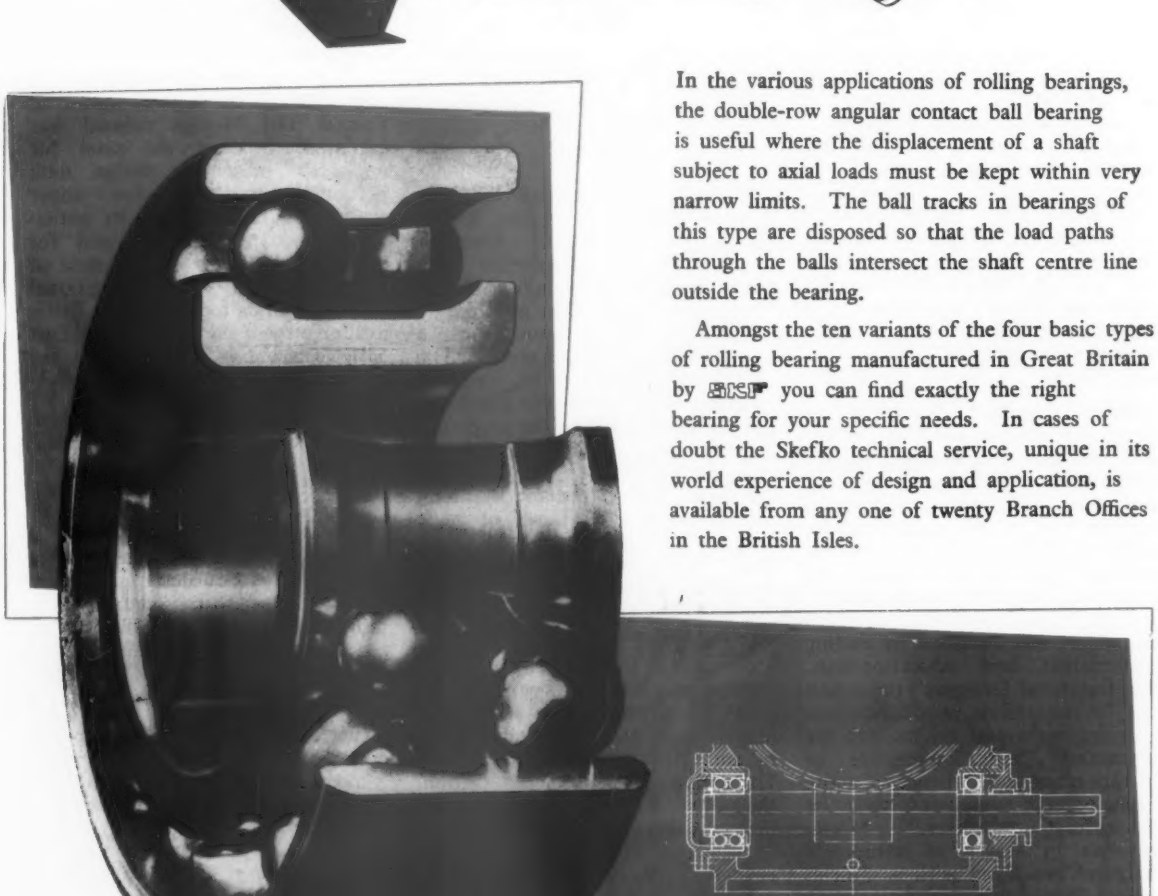
Evaluation of Nuclear Power Reactors.—Publication of "a uniform procedure for use in the evaluation of nuclear power reactors", is announced by the Atomic Industrial Forum. The 44-page manual was prepared to meet the need for uniformly presenting design data pertaining to a reactor under evaluation, for outlining its anticipated cost performance, and for describing both the current state of its development and the additional developmental requirements. It is available from the Forum at 3 East 54th Street, New York 22, at the single copy price of $1·50.

Steelwork Design.—The British Constructional Steelwork Association have issued a very useful technical publication which examines B.S. 449: 1959 clause by clause and shows exactly how it differs from B.S. 449:1948. A number of worked detail design examples are included to illustrate the differences. Copies are available from the association's office at 94/98 Petty France, London SW1. The author is Mr. Lewis E. Kent.

Exporters' Guide.—The latest publication by the Gauge and Tool Makers' Association, of Standbrook House, Old Bond Street, London W1, is a booklet entitled "A Simple Guide to Prospective Exporters", which has been produced with the particular object of assisting firms wishing to enter the field of overseas trading for the first time. The subjects dealt with include representation in foreign markets, how to appoint an agent, methods of exporting, methods of payment, etc., etc., and copies are available at 3/6 each, post-free, on application to the offices of the association.

Only SKF can offer such a wide selection of British made bearings





In the various applications of rolling bearings, the double-row angular contact ball bearing is useful where the displacement of a shaft subject to axial loads must be kept within very narrow limits. The ball tracks in bearings of this type are disposed so that the load paths through the balls intersect the shaft centre line outside the bearing.

Amongst the ten variants of the four basic types of rolling bearing manufactured in Great Britain by SKF you can find exactly the right bearing for your specific needs. In cases of doubt the Skefko technical service, unique in its world experience of design and application, is available from any one of twenty Branch Offices in the British Isles.

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G180A

BUSINESS & PROFESSIONAL

Personal

Mr. Kenneth Druce, D.F.H., A.M.I.E.E., has been appointed sales manager to The English Electric Company of South Africa (Pty.) Limited, and will join the staff in the Johannesburg office. For the past two years he has been manager of the company's Bristol office responsible for the South-Western area, where he will be succeeded by **Mr. W. M. Todd.** Mr. Todd joined the firm in Glasgow in 1936. The following changes will be made in the company's organization in the eastern hemisphere. **Mr. E. C. Fox,** the company's general manager in India, will become managing director of The English Electric Company of Australia (Pty.) Limited at the beginning of January, 1960, in succession to **Mr. C. W. Goodman** who has passed normal retiring age. Mr. Goodman will continue full-time service as chairman of the Australian company. In India, **Mr. N. P. Dingwall,** former manager of the company's Calcutta office, will replace Mr. Fox as general manager.

Mr. Albert Maugham, deputy general manager of the David Brown Machine Tool and Tool Divisions, has retired on attaining the age of 65, though his services will continue to be available to the company on a part-time consultative basis. In the 28½ years which he has spent with the David Brown organization, resident at Tool Division, Park Works, Huddersfield, Mr. Maugham has become a leading authority on gear cutting tools and gear measuring equipment, serving for the last seven years on the B.S.I. Gears and Gear Cutting Tools Committee. Following Mr. Maugham's retirement, **Mr. W. F. Howe** has been appointed manager of the David Brown Tool Division. Mr. Howe was formerly manager of the machine tool and contract engineering division of British Northrop Limited, Blackburn, and has also held management positions with The Plessey Company Limited, Swindon, and with Linread Limited, Birmingham.

Mr. E. Masters, Director of the fighting vehicles research and development establishment at the Ministry of Supply, takes up the position of managing director of Petters Limited, and Hawker Siddeley (Hamble) Limited, on January 1, 1960. He will also become a member of the board of Hawker Siddeley Industries Limited. Mr. Masters succeeds **Mr. D. K. Fraser, M.I.Mech.E., M.I.Mar.E.,** who has resigned his various directorships with the Hawker Siddeley Group on being appointed a joint managing director of G. A. Harvey & Company (London).

Mr. F. H. Beasant, B.Sc., M.I.Mech.E., M.I.E.E., M.I.Loco.E., has returned to England from Australia to take up an appointment as deputy manager of the traction division of the Brush Electrical Engineering Company, a member of the Hawker Siddeley Group. Mr. Beasant, who has had long experience in the traction field will be based at headquarters at 32 Duke Street, St. James's, London.

Mr. J. E. Smith is resigning the post of director of Richardsons Westgarth & Co. Limited, of Wallsend-on-Tyne, and managing director of their subsidiary, The North Eastern Marine Engineering Company, in order to take up the position of managing director of the National Gas & Oil Engine Company Limited on January 1, 1960. He will also become a member of the board of Hawker Siddeley Industries Limited.

Mr. James E. Robinson, M.I.Mech.E., M.I.Mar.E., chief engineer of Hepworth & Grandage Limited, Bradford, manufacturers of Hepolite engine components, has been appointed to the board.

Mr. Anthony Cockle has been appointed reliability engineer with The Solartron Electronic Group Limited, of Thames Ditton, Surrey.

Mr. J. A. Harley, B.A.Sc. (Toronto), has been appointed deputy managing director of Steele and Cowlishaw Limited, of Hanley, Stoke-on-Trent, one of the companies in the Baker Perkins group. Mr. Harley held executive positions with Canadian Baker Perkins Limited, of Brampton, Ontario and Baker Perkins Inc., of Saginaw, U.S.A., before joining Baker Perkins Limited in this country in 1958.

C.A.V. LIMITED of Acton, London W3, announce the appointment of **Mr. A. E. W. Austen, B.Sc., Ph.D., A.M.I.E.E., F. Inst.P.,** as chief engineer of C.A.V. **Mr. W. E. W. Nicolls, B.Sc.,** who has been chief development engineer since 1948, has been appointed to the position of chief engineer for overseas operations.

AT the General Election on October 8, 1959, **Mr. John H. Osborn,** a director of Samuel Osborn & Co. Limited, steelmakers, steel-founders and engineers' toolmakers, was elected Member of Parliament (Conservative and Liberal) for the Hallam Division of Sheffield.

Mr. P. A. Cheesman, area representative for W. E. Sykes Limited, Staines, Middlesex, is shortly to take up a new appointment in the Sykes organization in the United States. His position here will be taken by **Mr. G. P. Jones,** who has recently returned after a period with the Sykes Tool Corporation, Toronto, Canada.

Mr. L. B. Devins has been appointed general manager of The Sheffield Wire Rope Company Limited, of Darnall, Sheffield. He was formerly sales manager, steel rope department, of Wrights' Ropes Limited.

SIR W. H. BAILEY & CO. LIMITED (Albion Works, Patricroft, Manchester) announce that **Mr. A. Kirkham** has resigned from the board of directors and joined the Foundries Division of David Brown (Industries) Limited, Penistone.

Mr. J. W. Ashley, B.Sc., chief engineer of Atomic Power Constructions Limited since the inception of the company, has been elected to the board as technical director. Mr. Ashley heads the team responsible for the design and construction of the 500 MW nuclear power station now being built by the company for the C.E.G.B. at Trawsfynydd, North Wales.

Sir John Pascoe has accepted an invitation to join the board of the Timken Roller Bearing Company of Canton, Ohio.

METROPOLITAN - VICKERS ELECTRICAL Company Limited, announces that **Mr. J. Dummelow, M.A., A.M.I.E.E.,** has been appointed manager, publicity department.

Mr. R. L. Herring, managing director of Lamson Engineering Company Limited, since 1945, resigned on September 30 due to ill health but will continue to serve as a director. **Mr. D. C. H. McLean** has been appointed to the position of managing director as from October 1, 1959.

ACHESON INDUSTRIES (EUROPE) LIMITED, announces the election of **Mr. Edward A. Smith** to the board of directors of Acheson Colloids Limited, their principal subsidiary, who shortly celebrate the 50 years of their manufacturing activities. Mr. Smith was technical manager of Acheson Colloids Limited before being promoted to his present senior position of executive manager, Acheson Industries (Europe) Limited.

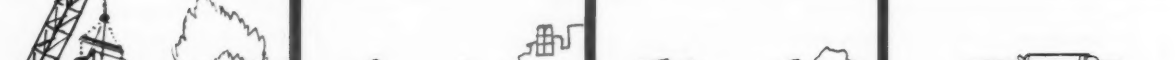
Mr. John Harrison has been appointed managing director of Atlas Copco (Great Britain) Limited, of Maylands Avenue, Hemel Hempstead, Hertfordshire, in place of **Mr. J. C. Greig,** who has resigned.

Mr. J. D. Riddle, B.Sc.(Eng.), D.I.C., A.M.I.Mech.E., A.M.I.E.E., has been appointed manager of the British Thomson-Houston Turbine Factory, Rugby.

Designers looking for a 'sales plus' specify

Fordson Power

They look for Fordson Power because it gives equipment the stamp of reliability, ensures high output at low cost, and because it has the backing of the Ford world-wide service and spares organisation. There are Fordson Industrial Units in the 30-40 and 40-50 b.h.p. classes, in more than 100 different assemblies. Fit Fordson and you get all the benefits of quality mass-production from Ford's famous Dagenham factory, the biggest producer of mobile power units. Fit Fordson, the unit tailor-made to your requirements. Send for detailed specifications today.



Wise buyers insist on **Fordson Power**

INDUSTRIAL SALES DEPARTMENT, TRACTOR DIVISION
FORD MOTOR COMPANY LIMITED, DAGENHAM, ESSEX

WICKMAN LIMITED announce the appointment of **Mr. R. J. Dixon** as director and general manager of their machine tool manufacturing company.

Mr. B. Malone has joined the staff of the Electric Resistance Furnace Company Limited, as manager of the new Efco foundry division. Mr. Malone has been for many years works manager of Southern Foundries Limited.

BRITISH INSULATED CALLENDER'S CABLES Limited announce that **Mr. R. A. Turpin** who was appointed representative at Exeter in 1949, has been appointed manager of their Exeter branch, at 40 Whipton Village Road, Whipton, on the retirement of **Mr. H. F. G. Bicker.** Mr. Bicker joined Callender's Cable and Construction Company Limited in 1913. **Mr. C. H. Frankland, M.I.E.E.,** has retired from the board of BIC Construction Company Limited, and **Mr. R. Betley** has been appointed an executive director. Mr. Frankland joined Callender's Cable and Construction Company Limited in 1910 and Mr. Betley in 1919.

Mr. R. C. McCormick, B.A., M.Sc., has joined Airtech Limited, of Haddenham, Bucks, as chief electronics engineer. Mr. McCormick was formerly with Mullard and Ultra Electric Special Products Division.

Mr. Wilfred Hirst formerly manager of the gear division of George Angus & Co. Limited has resigned in order to take up an executive appointment with Tweedales-Smalley Limited, of Rochdale. He will be succeeded by **Mr. H. F. Macintosh,** formerly technical sales manager of Whites Marine Engineering Company Limited, Hebburn.

Mr. Russell C. Nelson has been appointed marketing manager of the general products group for European sales for a number of Du Pont product lines.

IN token of twenty-five years' service with Hoover Limited, **Mr. Harold L. Madeley,** production manager at Hoover Limited's Perivale factory group was recently presented by the company with a gold watch.

Mr. L. J. W. Bailey has succeeded **Mr. E. F. Hingeley** as general manager of Dunlop (Germany). Mr. Bailey, who joined Dunlop in 1937, was previously general manager of the India Tyre & Rubber Company.

Mr. B. Williams has been appointed resident technical sales representative at the Bristol office of Crofts, power transmission engineers, of Bradford, Yorks., in place of **Mr. Dawson,** who has resigned.

To succeed **Mr. R. B. Tucker,** who has resigned from the company to take up another appointment, Siemens Edison Swan Limited have appointed **Mr. H. A. Parrott** as assistant home sales manager, cable division. Mr. Parrott joined the company in May this year on a special duties assignment to the cables division. Previously he was with the Cable Makers Association for 34 years. **Mr. Andrew Calley** has been appointed manager of the London district office following the resignation of **Mr. J. A. E. Trinder.**

THE following have been appointed special directors of English Steel Corporation Limited, the parent company of the group. **Mr. K. Chatterton, A.M.I.C.E.,** chief engineer, parent company; **Mr. A. M. Simmers, A.C.A.,** secretary and chief accountant, parent company; **Mr. A. Taylor, A.C.A.,** chief accountant, subsidiary companies.

AIR TRAINERS LINK LIMITED announce that the chairman of their board of directors, **Mr. J. M. Wallace,** has relinquished his office in order to reduce his commitments and so enable him to give more time to his other interests. **Air Chief Marshal Sir John Baker, G.B.E., K.C.B., M.C., D.F.C.,** has been elected to the board of A.T.L. Limited and has been appointed chairman. The following have also been elected directors of the company: **Lieutenant-General Sir Frederick George Wrisberg, K.B.E., C.B.,** and **Mr. J. W. Murray,** chairman of the General Precision Equipment Corporation of New York.

THE chief engineer of the car body division of The Pressed Steel Company Limited, **Mr. Harry R. Barber,** has been appointed a member of the Motorcar Body Divisional board as assistant director of engineering. He joined the company as chief development engineer in 1956. The company's works director at Cowley **Mr. Robert N. Davies** who is also chairman of the Motor Car Body Divisional Board has been appointed a local director of the company.

SHARPLES CENTRIFUGES LIMITED have appointed **Mr. Keith J. Daniells** as a chemical engineer to be concerned mainly with Sharples processes, and the application of a wide range of separational equipment to the chemical and food industries.

Major W. R. Brown has relinquished the post of joint managing director of The Power-Gas Corporation Limited, but continues as chairman of the board. **Mr. C. E. Wrangham** is now sole managing director of the company and continues as vice-chairman of the board.

THE DISTINGTON ENGINEERING COMPANY Limited, Workington, (branch of The United Steel Companies Limited) announce that **Mr. A. E. Bell,** formerly general sales manager, has been appointed commercial manager responsible for the buying department of the branch.

Mr. L. L. Boyd, at present managing director, The United Steel Companies (India) Private Limited, and director, The United Steel Companies (Pakistan) Limited, is shortly to return to the United Kingdom and in March, 1960, he will take up the position of deputy commercial manager at United Steel's Steel Peech and Tozer branch, Rotherham.

Obituary

WE regret to record the death of **Mr. William Herbert Grinsted, O.B.E., F.C.G.I., M.I.E.E.,** Mr. Grinsted was for nearly 50 years a senior technical executive with Siemens Edison Swan Limited, and was a pioneer of telephone engineering in this country. He retired in April, 1958, as director of engineering to the company.

WE regret to record the death of **Mr. F. W. Leake, M.I.E.E.,** sales manager for British Insulated Callender's Cables Limited. Mr. Leake joined BIC in 1923.

Addresses

MOXEY LIMITED have changed their head office address to Birmingham Road, West Bromwich. Telephone: West Bromwich 1971, 6 lines.

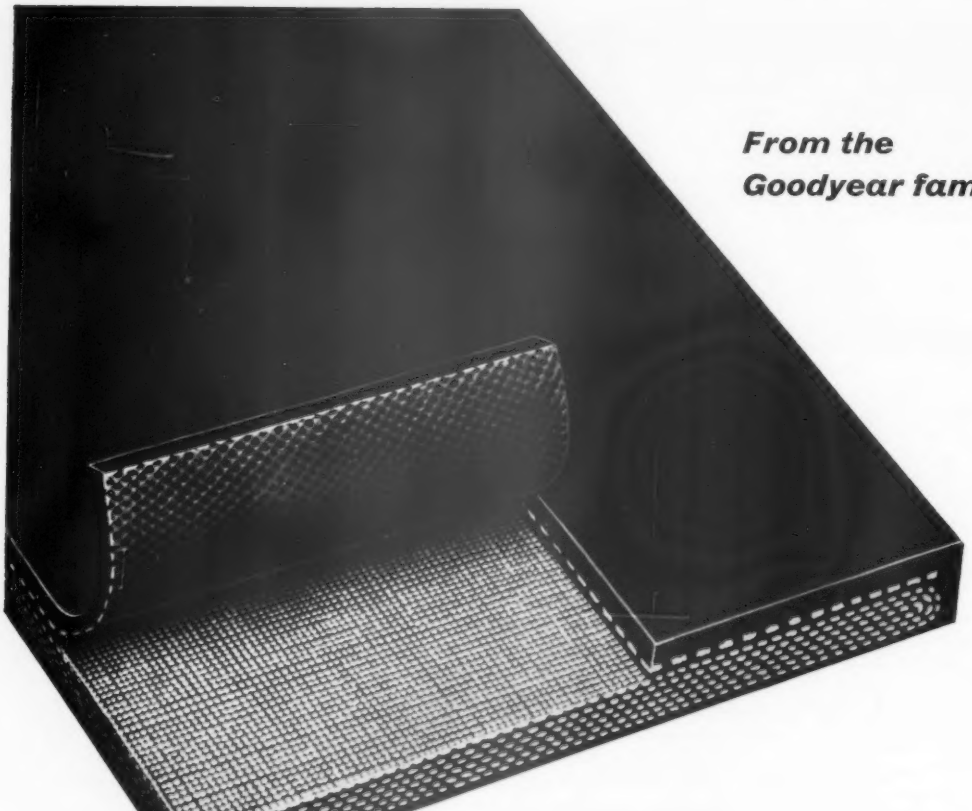
AEROX LIMITED engineering works have now moved from Crawley, Sussex, to larger premises at Chalford, Stroud, Glos.

EXPANDITE LIMITED, Chase Road, London, NW10 have opened a Northern factory and depot at Trafford Park Road, Trafford Park, Manchester 17, under the management of Mr. Roland Bell, who is also the North Western area manager of Expandite Limited. Telephone: Trafford Park 1285/6. Telex: 25420.

THE South West England and South Wales branch office of Elliott Brothers (London) Limited has moved to 55 Westgate Chambers, Newport, Monmouthshire. Telephone: Newport 65710.

HOLMAN BROTHERS LIMITED, Camborne Cornwall, manufacturers of compressed air equipment have opened new premises at Lightning Way, Alvechurch Road, West Heath, Birmingham 31. The new branch sales manager, Mr. C. E. J. Bishop, has been with the Holman Group for more than ten years and has been associated with the Midlands area for many years.

SMALL & PARKES LIMITED, (makers of Don brake linings and disc brake pads) have now installed TELEX at their registered offices and works, Hendham Vale, Manchester 9, and at their London office 251 Kingston Road, SW19. The numbers are: *Manchester:* Telex 66161. "Answer back" code—DON, Manchester. *London:* Telex 25439. "Answer back" code—DON—London.



From the Goodyear family tree

BELTING THAT TAKES A LOT OF BEATING

TRANSMISSION BELTS

CONVEYOR BELTS

V-BELTS

HOSE

FENDERS

Whatever material you want to move, whatever the conditions, you'll find the conveyor belt for the job in the Goodyear family tree! For abrasive coke or hot sinter . . . oily materials or sharp stone . . . food and coal . . . a 'job-designed' Goodyear belt is your best choice for longest, low-cost performance. Special features include: good troughing, high impact resistance and flex life, and resistance to mildew. Get in touch with Goodyear now for Britain's most comprehensive conveyor belt service.

- Tough cover compounded to suit job
- Breaker fabric between cover and carcass — where required
- Plies of close-woven cotton duck, or synthetic fibres mildew inhibited
- Skim coat between plies to increase flexibility, prevent separation
- Substantial edge cover to resist wear

GOODYEAR

THE GREATEST NAME IN RUBBER

The Goodyear Tyre & Rubber Company (G.B.) Ltd., Industrial Rubber Products Dept., Wolverhampton.

THE telephone number of the Worcester branch office of British Insulated Callenders Cables Limited has been altered to Worcester 26966/7. The Plymouth depot, at 58/59, Regent Street, Plymouth, is now an independent branch. Mr. C. E. B. Baker, who has been in charge of the depot since 1945, will continue as branch manager.

THE telephone number of Alley & Maclellan Limited, Bromyard Road, Worcester, is now Worcester 27225.

NEW offices in Stockholm at "Alvajo", on the outskirts, have been opened by Simmonds Aerocessories A.B., a member of the Firth Cleveland Group, Mr. C. Edgren is the managing director of the Swedish Company, Simmonds Aerocessories A.B.

THE Midland regional office of the Board of Trade and the Midland Regional Board for Industry are now at Somerset House, Temple Street, Birmingham, 2 (telephone Birmingham Midland 8221).

CHAS. H. WINDSCHUEGL LIMITED (1 Leadenhall Street, EC3.) a member of the Amber group of companies have left their City address and are now at offices at the group headquarters (11a Albemarle Street, London W1, Telephone: MAYfair 6161).

THE BRITISH INSTITUTE OF MANAGEMENT has opened in Bristol its sixth regional office, St. Giles House, Quay Street, (Bristol 24763). It is the headquarters of the South Wales and West of England Regional Council of BIM, the chairman of which is Mr. R. Ashley Hall, deputy-chairman of Jenson and Nicholson Group Limited. The new regional manager is Mr. I. D. Cunningham.

ALUMINIUM UNION LIMITED has changed its name to Alcan (U.K.) Limited.

DEXION LIMITED, makers of slotted angle and accessories, have announced changes of name for two of their products. *Tecton* is the new name for the engineered wood beams, previously known as Tecon. "*Open Steel Plank*" replaces the name "Multi-Purpose-Grid" for Dexion's new all-purpose grip which can be used for anything from floor grids to steps or car ramps.

A SOUTH WALES area sales office has been established by Birlec Limited in Cardiff. Mr. W. H. Statham, who is appointed area representative for South Wales, has his headquarters at Associated Electrical Industries Limited, Mervyn House, Frederick Street, Cardiff, telephone Cardiff 28511.

G. HUNTER (LONDON) LIMITED have closed their South Benfleet factory and moved to Grays, Essex.

Contracts and Work in Progress

BIRLEC-EFCO (MELTING) LIMITED.—Order for 21 in. dia arc melting furnace for English Steel Corporation.

FARMER BROTHERS (SHIFNAL) LIMITED. (M.I. Group).—Contract for aircraft hangar doors for Spain. Mechanical and electrical equipment provided by Fawcett Preston Limited.

TANGYES LIMITED.—Canadian order for $600,000 for the supply of hydraulic equipment to Canada Iron Foundries Limited.

HEENAN & FROUDE LIMITED.—Order for a Heenan Dynamatic MK.8 dynamometer for D. Napier & Son Limited, for testing Deltic engines at the Simons Town Naval Base, Cape Town, South Africa.

Order for four hydraulic dynamometers for the Arabian American Oil Company for Saudia Arabia.

E.M.I. ELECTRONICS LIMITED.—Contract from U.K.A.E.A. 43 Emirad Monitors (hand and clothing monitors).

Computer installations for Ministry of Pensions.

ELLIOTT BROTHERS (LONDON) LIMITED, and Siemens Edison Swan (Australia) Pty. Limited.—Orders value over £120,000 sterling for electronic recording and control equipment for the Cockle Creek works of Sulphide Corporation Limited, New South Wales.

FOSTER, YATES & THOM LIMITED.—Treble pass self-contained boiler for Sterkfontein Hospital, Krugersdorp, Transvaal.

LEYLAND MOTORS LIMITED.—Contract for fleet of 120 Leyland Comet tipping chassis valued at over £300,000 placed with Ashok Leyland Limited of Madras by the Central Public Works Department, Bombay State.

A.E.I. TURBINE GENERATOR DIVISION.—Contract approaching £5M. covering the supply and erection of two 300-MW turbine generator units placed by the Central Electricity Generating Board for the West Thurrock power station.

A.E.I. LIMITED, HEAVY PLANT DIVISION.—Supply of electrical plant valued at £325,000 for cold strip mill at the Shotton Works of John Summers & Sons Limited.

Two A.C. winders for two South African mining companies.

BRITISH RAILWAYS. (SCOTTISH REGION).—Contracts placed with Steels Engineering Products Limited, Glasgow, for diesel-electric mobile cranes; Butler Machine Tool Company Limited, Halifax, for two rail planing machines; Kullen & Company K.G. Germany for carriage washing plant.

HENRY BALFOUR & CO. LIMITED.—Orders from East Midlands Gas Board and the South Western Gas Board for plant involving the recently developed Frodingham Desulphurizing Process.

SIR W. H. BAILEY & CO. LIMITED.—British made turnstiles for international airport at Brussels.

CABLE AND WIRELESS LIMITED.—New cable repair ship at a cost of over £1M. to be built by Cammell Laird & Co. (Shipbuilders and Engineers) Limited.

THE HYMATIC ENGINEERING COMPANY Limited.—£10,000 order for 12 mobile air compressors from the Greek Government.

LEO COMPUTERS LIMITED.—Order for a Leo automatic office for Standard-Triumph.

Calling LSE Ex-apprentices

LAURENCE, SCOTT & ELECTROMOTORS Limited would like to hear from ex-apprentices with whom they have lost touch. It is hoped to arrange for a get-together, possibly during the run of the electrical engineers exhibition next year. Ex-apprentices are asked to give details of their present whereabouts, either to Mr. W. F. Symes at Gothic Works, Norwich, or by telephone to Mr. T. J. Barfield at Temple Bar 5223.

Film News

A BOOKLET has just been issued by The Carborundum Company Limited (Trafford Park, Manchester 17) illustrating eleven films produced by the company's film unit. They are for 16 mm sound projection gear and all but two are in colour. Application should be made to The Films Department, Carborundum Company Limited, Trafford Park, Manchester 17.

New Association

THE Association of Hydraulic Equipment Manufacturers with offices at 38/40 Eccleston Square, London SW1, has been formed by British hydraulic equipment firms who have found the need for a central national organization to look after the interests of the industry as a whole; to collect and to distribute technical information; to advise on exhibitions for the industry at home and abroad, and to encourage and sponsor research for the benefit of the members.

Insurance for Capital Goods

THE Export Credits Guarantee Department is prepared in appropriate cases to insure capital goods business with Yugoslavia on terms of credit extending to five years instead of three, from date of shipment.

Erratum

Harrison 12 in. Lathe.—In our September issue, an error inadvertently appeared in the T. S. Harrison advertisement. This featured the Harrison 12 in. swing lathe and the price stated, £420, is correct for this lathe. Unfortunately, in the text and specification it was mentioned as the 11 in. lathe.

BIGGEST AND WIDEST RANGE EVER OF CARBIDE TIPPED DRILLS!

Pioneers in carbide tipped masonry drills, the Rawlplug Company has gone still further ahead with the widest range of percussion, vibration and rotary drills obtainable anywhere. Whether its for hand or power use, you're bound to find the type and size you want in the Rawlplug range.

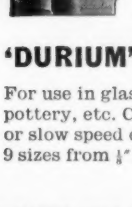
'DURIUM'
TIPPED MASONRY DRILLS

So famous have these amazing drills become that the name DURIUM tends to be used for any drill of its general type. *Don't be misled by this.* DURIUM means the special New Process, almost diamond-hard, carbide tip developed and made only by the Rawlplug Company. *No* other drill is a genuine Durium. DURIUM Drills give really sensational cutting performances in brick, tile, cement, slate, etc. They are silent in operation and have a quite exceptional long-service capacity for withstanding the abrasive action of masonry that so quickly ruins ordinary drills. Another exclusive feature of Durium Drills is their patented rapid-helix flute, which forces out spoil and prevents clogging. Only a Durium Drill—a *genuine* Rawlplug Durium—gives such life and service. First resharpening is FREE!

For use in Wheelbrace or slow speed electric drill

17 sizes 5/32″ to 1″ cutting diameter and **11** *long series* ¼″ to 1″ cutting diameter for up to 16″ drilling length.

'DURIUM' TIPPED HAMMER DRILLS



For percussion drilling in hard materials such as Granite, Blue Bricks, Concrete etc., Durium Hammer Drills have a very much longer life than ordinary percussion drills. They can be used in most electric Hammers and some type of Pneumatic Hammers. 13 sizes from 7/16″ nominal drill diameter to 1¼″.

'DURIUM' TIPPED GLASS DRILLS

For use in glass, china, vitrolite, pottery, etc. Can be used in a wheelbrace or slow speed electric drill.
9 sizes from ⅛″ to ½″ cutting diameter.

'VIBROTO'
HARD TIPPED DRILLS FOR VIBRATORY DRILLING

Vibroto Drills are specially manufactured for use with the Vibroto Drilling Machine, —a high efficiency power tool which allows of two vibratory actions (Light Rapid and Heavy Slow), and also a rotary action for use with standard Durium masonry Drills or ordinary Twist Drills. With their special cutting angle metallic carbide tips, and the high grade steel shanks heat-treated to withstand abrasion, Vibroto Drills put up spectacular performances in the drilling of concrete and other hard materials. *Demonstrations* can be carried out by Rawlplug Technical Representatives anywhere in the British Isles.

10 sizes 5/32″ up to 15/32″ cutting diameter.

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These drills are designed for hole boring in concrete, hard brickwork and tiles with portable rotary action tools. They have from four to six cutting edges (depending on size) and if one should be damaged the remainder will go on cutting. Spoil is automatically carried away through the cored shank and ejected via the slot.

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Rocol Lubricants for Machine Tools

Some useful notes on "Suggested Applications of Rocol Molybdenized Lubricants for Machine Tools" have been produced by Rocol Limited, Rocol House, Swillington, Leeds, and General Buildings, Aldwych, WC2. The general applications of Rocol molybdenized lubricants to beds and slides (prevention of sticking and wear), lead screws (smooth action and retention of accuracy), control valves (ease of action and correct regulation), change wheels and open gears (wear reduction and elimination of back-lash) and thrust washers (wear reduction) are indicated. More specific recommendations are made for a number of machines—grinding, boring (including jig borers), planing, radial drilling, shaping, milling, lathes and gear cutting, involving the wide range of Rocol molybdenized lubricants, which provides the means by which the useful life of machine tools and components can be increased and precision maintained. Recommendations by some machine tool makers for the use of Rocol products in their designs are indicated.

"Asmag" Automatic Motor Speed Control

Laurence, Scott & Electromotors Limited, Norwich, have added a further publication (No. 154) to their series on magnetic amplifiers and associated equipment. The new one deals exhaustively with the use of the Asmag equipment in the control of N-S variable speed a.c. motors. There are two types of control and both can be simply adapted for torque, tension or similar control purposes as well as for pressure, level and other process control requirements—beta ray thickness gauging is an example. Group driving is another use and so is voltage control of frequency changers, rectifiers, condensers, heaters, etc.

Graticules and Divided Scales

The general catalogue of Paton Hawksley Electronics Limited, Rockhill Laboratories, Keynsham, Bristol, gives particulars of the Merton/N.P.L. and other diffraction gratings which they manufacture, and also their graticules, and their service for ruling master divided circles and making copies. They also offer a bidirectional sensing head which can be used as a height gauge or caliper and in remote handling equipment. Another product is a measuring microscope which uses photoelectric cells to record the passing of diffraction patterns.

Hymatic Hydrovane Compressor

A new edition of a leaflet describing the Hymatic Hydrovane mobile compressor type 98P100 has been issued by the manufacturers—The Hymatic Engineering Company Limited of Redditch, Worcs. Printed in three colours the leaflet includes eight photographs of the compressor operating pneumatic tools under widely differing conditions, including one taken at high altitude in the Alps. A schematic illustration shows the principle of operation of the patented compressor unit. Figures for performance, dimensions and weights are given in both British and metric units.

Link V-Belting

A new product of Graton & Knight Limited, of Warwick Road, Boreham Wood, Herts., is described in a newly issued folder. It is "Grey Knight" link V-belting which has a 40° angle and is made in sections to suit the same pulleys as M, A, B and C endless V-belts. An advantage of the link belt is the ease with which it can be lengthened or shortened and fitted to interior drives without any necessity for dismantling parts of the machinery.

Trade Literature

Back-pressure Turbines

To meet the steam and power requirements of various manufacturing processes, a range of 'English Electric' standard back-pressure turbines has now been designed incorporating experience gained over many years. The turbines are suitable for operation under high steam conditions and include features which ensure high sustained economy. The specification described in a new 16-page publication issued by The English Electric Company Limited, Small Steam Turbine Department, Whetstone, Nr. Leicester, is typical of the present range of geared back-pressure turbo-alternator sets for outputs from 400 kW to 5000 kW.

Machine Slideway Protection

There is much to be gained by protecting machine tool slideways from abrasive particles, fine swarf, etc. The machines maintain their accuracy and general performance longer, less maintenance is required and more use is made of the capital cost of the machine. The protection is simply effected by Gatan, an industrial leather of exceptional quality, which is made up in a concertina form into slideway covers. The principle has been applied with equal success to other kinds of machinery and to rams as well as slideways. Full details are given in a new illustrated leaflet which is available on request to George Angus & Co. Limited, 152-158 Westgate Road, Newcastle upon Tyne. 1.

Ladles and Receivers

The fourth new foundry leaflet issued this year in connexion with Incandescent equipment deals with ladles and receivers for molten metal. All types of ladle are illustrated from the simple hand shank to the large power operated, the latter including both lip and bottom pouring ladles. The receivers illustrated range from one of 35 cwt capacity to a 6-ton plant. The leaflet, which also includes examples of crucible furnaces, dust collectors, ovens, electric furnaces, and gas burners, is available on request from The Incandescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham.

Stainless Steel in the Dairy Industry

Stainless steel is used extensively for the metal parts of milking units and refrigerated holding tanks, for bulk transport containers, and for weighing bowls, storage tanks, pasteurizers and bottle filling and capping machines. It is also widely used in modern butter, cheese and ice cream plants. An illustrated brochure describing all this and also giving technical notes, design criteria and fabrication details is obtainable on application to the Stainless Steel Manufacturers' Association, 4 Melbourne Avenue, Sheffield 10, Yorkshire.

Electrical Connectors

D. J. Equipment (Hersham) Limited, 43 Queens Road, Hersham, Walton-on-Thames, Surrey, have issued a leaflet describing a new range of electrical connectors, terminal lugs and clamps. These fittings are made of electrolytic copper and eliminate soldering. The design ensures a secure, even pressure giving good electrical contact with material which is corrosion resistant and has conductivity identical to copper conductors. This leaflet will be of particular interest to manufacturers of transformers, electric traction equipment, busbar chambers and switchgear.

Large Induction Motors

A 12-page publication from the Electrical Plant Sales Department of The English Electric Company Limited, Stafford, deals with large squirrel-cage (Class L) and slipring (Class LSF) induction motors for speeds up to 1800 rpm, and outputs up to the largest required. Seven different types of enclosure can be supplied.

Package-type Diesels

Publication DE/217 from The English Electric Company Limited, Diesel Engine Division, Rugby, gives examples of oilfield installations incorporating 'English Electric' diesel engines, in particular illustrating projects embodying 'package' type diesel sets which have been specially developed for oil-field duty.

Honeywell Micro-switches

A folder from Honeywell Controls Limited, Ruislip Road, Greenford, Middlesex, illustrates the different micro-switches made by the company and gives appropriate references to more detailed catalogues and data sheets.

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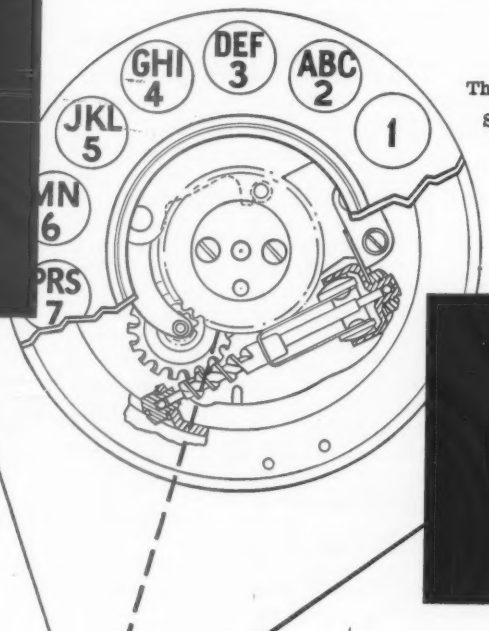

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Adjustable Lighting Fittings

Robust lighting fittings specially designed for industrial use are described and illustrated in List 10, newly issued by John Dugdill & Co. Limited, Buxton Road, Hazel Grove, Near Stockport. Of particular interest is the wide range of adjustable fittings for attaching to walls, ceilings, benches and machines.

Roof Ventilator

A new roof-mounted extractor for all types of industrial buildings is described in catalogue RE5 issued by Greenwood's and Airvac Ventilating Company Limited, Beacon House, Kingsway, London WC2. The "Mechavent" as it is called is made in a range of sizes for either sloping or flat roofs and is made of heavy gauge hardened aluminium. It is fitted with an extracting fan and special motors can be supplied to work under "resistance" conditions, and for speed regulation.

Turbines for Marine Auxiliaries

In addition to central power station and industrial sets, 'English Electric' steam turbines are made specifically for marine auxiliary duties, complying with the requirements of Lloyd's Register of Shipping. A 16-page publication issued by The English Electric Company Limited, Marine Department, Rugby, describes a specification for the present range of unit-type geared condensing turbines, from 350 kW to 1500 kW.

Zinc-rich Paint

A leaflet from Secomastic Limited, Bracknell, Berkshire, describes the use of "Galvafroid" zinc-rich paint for the protection of iron and steel. The paint is applied by brush and gives good protection provided the surface has been thoroughly cleaned.

New Factories

Bishop Auckland. G. Stephenson (Builders and Contractors) Limited, Chester Street. New fitters' shop at St. Andrew's Place.

Blaydon (Co. Durham). Valley Plastic Coaters Limited, Team Valley Estate, Gateshead. New factory in Chain Bridge Road. The architects are Wetherell, Lamb and Partners, 24 Picton Place, Newcastle upon Tyne.

E. S. Johnson and Company Limited, Heath Court, Newcastle upon Tyne. The architects for warehouse and offices at Chain Bridge Road are G. H. Gray and Partner, 52 Camden Street, North Shields.

Smith Patterson and Company Limited, ironfounders, Pioneer Foundry, have been granted permission to convert the public house "Pioneer Tavern" into offices.

Carlisle. British Railways have accepted the tender of Watlings Limited, Glasgow, for earthworks, drainage, and roadworks for a proposed marshalling yard, to cost between £4m. and £5m.

Cumberland. Electroflo Meters Limited, Maryport, and the Cumberland Curled Hair Manufacturing Company Limited. The contractors for proposed factory additions are Border Engineering Contractors Limited, Queen Street, Whitehaven.

Durham. The County Council has accepted the tender of J. Jeffreys and Company Limited, London at £265,828 for the mechanical services in connection with the erection of a new £2m. County Hall at Aykley Heads, Durham.

Imperial Chemical Industries Limited, (Paint Division), Slough, are to erect warehouses and offices on 3½ acres site at Belmont.

Newcastle upon Tyne. Royal Victoria Infirmary. Tenders are being obtained for the erection of boilerhouse (224,000 sq ft). The architects are J. H. Napper and Partners, 56 Eldon Place.

Pirelli Limited. Tyre store and offices in George Street. The architects are M. and H. Gatoff, 26 Mosley Street.

Aycliffe Properties Limited, P.O. Box 1. Aycliffe, Co. Durham, are planning the erection of a multi-storey parking garage and helicopter landing site in the Scotswood Road area, Newcastle.

South Shields. Middle Docks and Engineering Company Limited. Plans have been approved for new joiners', carpenters, and riggers' workshops. No contracts have yet been placed. The consulting engineers are Waterhouse and Rounthwaite, 165 Westmorland Road, Newcastle upon Tyne.

Sunderland. Hallgarth Steel Products (Sunderland) Limited, Monkwearmouth, are to lease 4,000 sq ft of land at East Cross Street for proposed industrial developments.

The Regent Oil Company Limited, 117 Park Street, London W1, are to proceed with the second stage of the scheme for storage tanks and ancillary equipment at South Docks.

Wallsend. Associated Lead Manufacturers Limited, Crescent House, Newcastle upon Tyne, are to erect a factory and ancillary buildings in Stephenson Street.

Ballyclare. The Ministry of Commerce is to erect a new factory.

Ballymena. Gallaher Limited are to make extensions to their factory.

Birkenhead. Moorhouse Bros. Limited, 55 Everton Road, Liverpool 6. The architect for the new factory at George Street is Fergus H. Frost, 73 Oxton Road.

Blackpool. James Pye Limited, Windmill Land Creamery, Kirkham, propose to erect a new factory.

Bolton. B. & F. Carter & Co. Limited, Albion Works, Waterloo Street. Works extensions.

Bradford. Robert Glew & Co. Limited, are considering extensions to their factory at Leeds Road, Greengate.

Brighton. West Instruments Limited, 51 Regent Street, are to erect a new factory at Lower Bevendean industrial estate, The architects are Clayton, Black & Daviel, 10 Prince Albert Street.

Cheltenham. Martin Cadbury (Printers) Limited, Bouncers Lane, are to make extensions to their factory.

Croydon. Harmer & Simmons Limited, Roebuck Road, Hainault. Factory extensions.

Dudley. John Barnsley & Sons Limited, Netherton are to erect a new works at Cradley Road.

Eccles. Regent Tyre & Rubber Company Limited are to make extensions to their Enterprise Works, Clifford Street.

Edmonton. A. E. Lindsay & Sons Limited. A new factory is to be erected at Angel factory colony.

Filey. Marshall Bros. (Bury) Limited, Ravine Hall, are to erect a new leather factory on the industrial estate.

Glasgow. Fibreglass Limited, Haethorne Street, Glasgow N2, have applied for permission to make extensions.

Guildford. A. Gray & Co. Limited. The architect for the new factory to be built at Woodbridge Meadows industrial estate is W. F. Price, 23 Beaumont Street, Oxford.

Heanor. Trent Concrete Company Limited, Nottingham, are to erect a new factory at Midland Road.

Leeds. Catton & Co. Limited, Chadwick Street are to erect new premises at Pontefract Lane, Knowsthorpe.

London. Mitchell Colour-card Company Limited, 5 Sandall Road. A new factory is to be built at Holmes Road, London NW15. The architects are Nicholson & Rushton, 2 New Square, Lincoln's Inn, London WC2.

Manchester. Hilson Wire Products Limited. Plans have been approved for extensions to the factory at Shentonfield Road, Northenden.

Neath. Aluminium Wire & Cable Company Limited, Port Tennant, Swansea. New factory.

Newbury. Proofed Packings Limited. Extensions to factory. The architects are Sutton, Griffin & Sweetnam, 87 Northbrook Street.

Wrappings & Packings Limited, 256 Kensal Road, London NW10. New factory in London Road.

Newhaven. Parker Pen Company Limited, 52 Railway Road. The contractors for extensions to works are Oxley & Bennett Limited, 3 Lewes Road.

Norwich. Sexton Son & Evered, St. Mary's Works, are to make extensions to their factory.

Oldham. Meters Limited, 26 Cross Street, Manchester 2. Works extensions.

Square Grip Reinforcement Designs Limited are to build a new factory.

Oxford. Hunt & Broadhurst Limited are to make extensions to their Ideal Works. Botley Road.

Portsmouth. Hinchley Engineering Company Limited, Unicorn Road. Factory extensions.

Romford. Jarman & Platt, Faringdon Avenue, Harold Hill. Works extensions.

Colvern Limited. Plans have been approved for extensions to the factory at Spring Gardens.

Southend-on-Sea. Industrial Press (Southend) Limited. The contract for the new factory has been let to Thomas Bates & Son Limited, Harold Wood.

M.T.E. Control Gear Limited, Progress Road, Eastwood. Plans for factory extensions have been prepared by Watkins & Park, 27 Rockleigh Avenue, Leigh-on-Sea.

Southport. Stirling Knitting Company, Manor Road. Works extensions.

St. Paul's Cray. Algraphy Limited, Willowbrooke Grove, London SE15. The contractors for the new factory are Lavender McMillan Limited, 54 Cheam Common Road, Worcester Park, Surrey.

Taunton. Steel & Glover Limited, Thomas Street. The architects for works extensions are Kenneth Steel & Hadley Coleman, 7 The Crescent.

Hallkirk, Thurso. A factory is planned by an English company for the manufacture of plastic clothing for employees at the Dounreay nuclear station.

Wick. Caithness Planning Committee has given approval for the erection of a £10,000 factory of 15,000 sq ft which will employ some 60 workers.

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Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on **2nd February, 1960.**

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THE proprietor of British Patent No. 733591, entitled "Safety Stand for a Flatiron", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of Patent No. 657048 for "Improvements in or relating to Machine-tools and the like", desires to secure commercial exploitation by licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

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THE proprietor of British Patent No. 753062, entitled "A method and apparatus for forming a true cylindrical surface on an elongated member, such as a crankshaft or a calender roll", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

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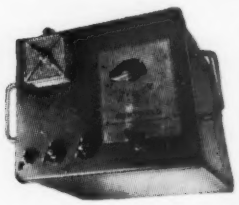

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